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# School fitness assessment and promotion: state and national evaluations with FITNESSGRAM

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# **School fitness assessment and promotion: State and national evaluations with FITNESSGRAM**

by

**Yang Bai**

A dissertation submitted to the graduate faculty  
in partial fulfillment of the requirements for the degree of

**DOCTOR OF PHILOSOPHY**

Major: Kinesiology

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## **DEDICATION**

I dedicate this dissertation to Dechuan Bai and Jing Zhang. They are the wonderful parents and give me the opportunity to pursue my dream.

I also want to dedicate this dissertation to Yuqing Chen, my great husband, who supports me all the way along.

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## **ABSTRACT**

FITNESSGRAM is the most widely used youth fitness assessment and reporting tool in school physical education programs. It has been adopted by thousands of schools in the United States and is required as a mandated statewide fitness assessment tool in several states. While developed primarily for educational applications, FITNESSGRAM also has utility for research and public health applications. This dissertation summarizes FITNESSGRAM outcomes from two large applications to advance research on youth fitness research and practice. The first application, Texas Youth Fitness Study, involved the evaluation of statewide data collected in the state of Texas as part of mandated school fitness testing. Approximately 2 to 3 million students were tested with FITNESSGRAM each year across Texas. Study 1 revealed significant school- and county-level correlates explaining the variability in weight status from Texas youth. Study 2 examined the longitudinal weight status change in children and adolescents in Texas. Positive shifts in weight status were found among most age groups in Texas youth between 2011 and 2014. The second application, NFL PLAY 60 FITNESSGRAM Partnership Project, involved over 1,000 schools across the United States where millions of students participated. Study 3 used individual student FITNESSGRAM data collected over 4 years of the project to examine the longitudinal effects of NFL PLAY 60 programming on youth aerobic capacity and body mass index. The results revealed significant improvements in aerobic capacity and body mass index profiles in schools that implemented the school-based health promotion programs. This dissertation work provides novel findings about youth fitness profiles and demonstrates the utility of evaluating the impact of school programming using systematic evaluation of FITNESSGRAM data.

## CHAPTER 1. INTRODUCTION

The topic of youth fitness has been of considerable interest since the early 20<sup>th</sup> century[1]. The emphasis in youth fitness has shifted from performance- to health-related fitness as accumulated evidence began linking fitness with childhood health and adulthood morbidity and mortality[2]. For instance, cardiovascular fitness has been shown to have a protective effect against several cardiometabolic risk factor, including clustered metabolic risk, total cholesterol[3], blood pressure[3-5], and high-density lipoprotein cholesterol (HDLc) [6, 3]. Moreover, the association between body composition and health outcomes is also well established in youth. To be specific, increased obesity rates have been shown to be significantly related with increased rates of cardiovascular risk factors[7-9] , metabolic syndrome[10], type 2 diabetes[11]. In addition, there is also strong evidence that obesity (and its relation with cardiovascular disease) tracks from childhood to adulthood <sup>[12-17]</sup>. These findings document the importance of better understanding factors that influence youth fitness and health.

The use of large scale fitness testing and surveillance to track youth fitness profiles was common from the 1950s into the 1980s. However, no national data were collected from the mid 1980s until 2012 when the Centers for Disease Control and Prevention (CDC) launched the NHANES National Youth Fitness Survey (NNYFS). Changes in prevalence of overweight and obesity have been well chronicled [18, 19], but there is need for better information on the status of health-related physical fitness (e.g., aerobic capacity) in youth. Thus, there remains a need for a surveillance system that can provide a comprehensive and cyclic examination of health-related fitness patterns on a large scale and across all age groups.

In 2007, Texas passed Senate Bill 530 which mandated the systematic collection of fitness data in all K-12 public schools. A comprehensive evaluation of the first year of statewide



Texas youth fitness data was conducted through the Texas Youth Fitness Study [20]. The study yielded important insights [21-23] but no follow-up research was done so far to study the secular trends since then. A number of other states including California, Florida, Georgia, Illinois have approved similar legislation requiring statewide fitness testing in selected grades or all grades. The ability to capture data through schools provides a tremendous opportunity to systematically evaluate educational, environmental and policy variables that may influence youth fitness [24-26] but, surprisingly little research has been done with these samples.

Considerable efforts have also been made to address declining fitness levels and increasing obesity in youth [27]. Schools have been identified as the most promising settings to educate youth about the importance of maintaining/adopting a healthy lifestyle and being physically active [28]. Numerous interventions have been conducted through schools settings and small but noteworthy effects have been consistently reported [29, 27, 30]. However, few evidence-based programs have been successfully translated into real world settings [31, 32]. Thus, there is a need to explore how to effectively capitalize the school infrastructure to advance youth fitness research and physical education programming.

The proposed dissertation is designed to help fill these research gaps. The studies utilized data collected from two separate studies, the Texas Youth Fitness Study and the NFL PLAY 60 FITNESSGRAM Partnership Project, to specifically advance research on youth fitness and health. The first study, the Texas Youth Fitness Study, is a four-year project designed to determine the secular trends in youth fitness levels. Other census data including school demographic data and county health indicators data were also merged to further explore factors that may explain differences in youth weight status across the state of Texas. The second study, the NFL PLAY 60 FITNESSGRAM Partnership Project, is an ongoing participatory research

network designed to provide schools with a diverse range of school fitness/physical activity promotion tools and objective assessments in of fitness. The study uses a naturalistic design that allows for natural variability in school characteristics, school policies and school programming. Schools have autonomy to decide what would work best for their students but data on engagement and involvement are systematically tracked to understand the impact of the programming. The project includes multiple levels (e.g. franchise, school, teachers, students) and multiple phases (i.e., fitness testing adoption followed by programming implementation) so it offers considerable potential to understand school level factors that may impact individual students fitness profiles. The project represents the largest study to date of school fitness programming and the longitudinal design presents an unprecedented opportunity to systematically examine the impact of the FITNESSGRAM and NFL PLAY 60 programming over time.

Both studies are large in scope and provide unique perspectives about the factors influencing the promotion of youth fitness. A comprehensive literature review will cover the key issues related to the studies included in the dissertation.

## CHAPTER 2. LITERATURE REVIEW

### Youth Fitness Overview

This section will provide an overview of youth fitness issues and provide background for the proposed studies. There are three main sections: 1) Overview of definitions and test components in youth fitness; 2) Summary of the empirical evidence on youth fitness relative to health markers among youth; 3) Comprehensive review on temporal trend of youth cardiovascular fitness and obesity.

### Definition and Components of Youth Fitness

Fitness is defined as “*a set of attributes that people have or achieve that relates to the ability to perform physical activity*” by the U.S. Department of Health and Human Services but there is a lack of universal agreement on the definition of fitness and its components, especially among youth. Historically, in early 20<sup>th</sup> century to 1950s, the purpose and focus of youth fitness was performance-related fitness, which is defined as “*the components of fitness that are necessary for maximal sport performance*”[33], due to the concerns regarding the youth readiness for military service. However, the focus of youth fitness testing started to shift to health-related fitness in 1960s because of the accumulated evidence between health and fitness[34]. Thus, the present review is on health-related fitness which has been described as “*the components of fitness that benefit from a physically active lifestyles and relate to health*”[33]. Although the terms and classifications are slightly different, there is common consensus in components of health-related fitness: 1) cardiorespiratory endurance, 2) body composition, 3) musculoskeletal fitness, and 4) flexibility [2, 35]. More specifically, cardiovascular fitness (CVF) is measuring “*the ability to perform large-muscle, whole-body exercise at moderate to*

*high intensity for an extended period of time*". Body composition (BC) is "*the sum of the basic components that makes up body weight, including fat, muscle, and bone content*".

Musculoskeletal fitness comprises three dimensions: muscle strength ("*the ability of skeletal muscle to produce force under controlled conditions*"), muscle endurance ("*the ability of skeletal muscle to perform repeated contractions against a load*"), and muscle power ("*the peak force of a skeletal muscle multiplied by the velocity of the muscle contraction*"). Lastly, flexibility is assessing the "*the range of motion achievable at a joint or group of joints*"[2].

### **Youth Fitness in Relation to Health**

The growing evidence of associations between fitness and health among adults in the past 30 years has improved understanding of the health benefits of physical fitness in reducing mortality [36, 37], cardiac/vascular/pulmonary morbidities[38], obesity [39], diabetes mellitus[40, 41], cancer [42], and bone health issues[43]. Unfortunately, relations between youth fitness and future health outcomes are more difficult to detect and less consistent. The biggest barrier is the methodological challenge, since it is impossible to apply the same type of investigations in youth that are common in adults. This is because unfavorable health outcomes such as heart disease, stroke, hypertension, diabetes mellitus, fracture etc. are not typically present among youth despite the presence of risky behaviors. However, considerable progress has been made in understanding the relation between physical fitness and health in youth. Instead of studying specific disease occurrence as health outcomes, several health risk factors (also called health markers) are now emphasized in research. Examples of common risk factors include cholesterol and blood lipids (e.g. total and HDLc, low density lipoprotein cholesterol [LDLc], triglycerides, insulin resistance, inflammatory proteins), blood pressure, adiposity, as well as skeletal and mental health. A number of systematic reviews have demonstrated

significant relationships between fitness and health indicators [44-50, 2, 51]. One study involved a total of 1709 9- to 10- and 15- to 16-year-old boys and girls from three regions of Europe participated in the European Youth Heart Study [52]. CRF was significantly associated with clustered metabolic risk (waist circumference, BP, fasting glucose, insulin, triacylglycerol and HDLc) before and after excluding waist circumference from the summary score. Further adjustment for waist circumference as a confounding factor showed a similar result, though the magnitude of the association was attenuated afterwards (standardized  $\beta$ =-0.09, 95% CI: -0.12 to -0.06 vs. standardized  $\beta$ =-0.05, 95% CI: -0.08 to -0.02) [52]. Another study evaluated a nationally representative sample of 3110 U.S. adolescents aged from 12-19 years using the National Health and Nutrition Examination Survey (NHANES) data in 1999-2002 [3]. The study revealed that total cholesterol and systolic BP were higher and levels of HDLc were lower among participants with low fitness than those who had high fitness [3]. A report from the Institute of Medicine reviewed 47 experimental studies, 24 longitudinal prospective studies, and 29 quasi-experimental studies examining the relation between CVF and health. The study revealed consistent associations between measured CVF and health risk factors, specifically between adiposity measures and cardiometabolic risk factors [2]. Further review of the high quality studies cited in the Institute of Medicine report provided evidence of causal associations. Farpour-Lambert et al. reported significant decreases in 24-h systolic BP (exercise-6.9 mm Hg vs. control 3.8 mm Hg), diastolic BP (-0.5 vs. 0), hypertension rate (-12% vs. -1%), Decreased body mass index (BMI) z-score and abdominal fat were associated with increases in CVF in a randomized controlled trial (RCT) of 44 pre-pubertal obese children (age  $8.9 \pm 1.5$  years) [4]. In another RCT study, Walther et al. conducted a one year randomized intervention study with 182 sixth-grader children. They reported an increase in peak  $\text{VO}_2$  (3.7 mL/kg per minute; 95% CI: 0.3 to 7.2) but they didn't

find significant differences for BMI and HDLc outcomes [53]. Another randomized controlled school-based trial with 268 Canadian children (age 9–11 years) was conducted by Reed et al. They found out that children in the intervention group had a 20% greater increase in CVF and a 5.7% smaller increase in blood pressure compared to the controlled group but no significant changes were found in BMI or in any of the blood profiles[5]. In addition, Kelly et al. [54]carried out an 8 weeks stationary cycling intervention with 20 overweight children and adolescents. Significant improvements were observed in the intervention group after 8 weeks compared with the control group for VO<sub>2</sub>peak (exercise group = 21.8[before] to 23.2 [after] mL/kg/minute vs control group = 23.4 to 20.9 mL/kg/minute), HDLc (exercise group = 1.02 to 1.10 mmol/L vs control group = 1.08 to 0.99 mmol/L), and brachial artery flow mediated dilation area under the curve (exercise group = 746 to 919 %.sec vs control group = 731 to 515 %.sec).

In addition to the direct or associational relation between CVF and health outcomes, the relationships between BC and health indicators have also been well established in youth. It should be noted that BC is viewed differently from other fitness components. BC is operationally considered as a component of fitness, a marker of health, and a modifier of fitness [2]. Numerous observational studies have established the dose-response relationship between obesity (especially abdominal obesity) with various of health outcomes (e.g., cardiovascular disease risk factor, metabolic syndrome, type 2 diabetes) in youth [8, 55, 11, 5, 10, 9]. Freedman et al. reported that 58% of overweight schoolchildren had at least one cardiovascular disease risk factor [8] from one of the landmark studies is the Bogalusa Heart study based on a sample of 9167 children and adolescents. A large study from the 1999-2008 NHANES (n = 3383 participants aged from 12 to 19 years old) also found that elevated weight status corresponds with higher risk factors for cardiovascular disease. The reported prevalence of having at least 1 cardiovascular disease risk

factors were 37%, 49%, and 61% for normal-weight, overweight, and obese adolescents, respectively [7]. This dose-response relation has also been confirmed by other studies [56-58], as well as direct attenuation of risks by higher level of CVF [59].

Numerous studies have also demonstrated that obesity (and its relation with cardiovascular disease) tends to track from childhood to adulthood [12-17]. A recent study on a large sample of participants (n=6,328) conducted by Juonala et al. [16] indicated that overweight or obese children who became obese adults had increased risks of type 2 diabetes, hypertension, dyslipidemia, and carotid-artery atherosclerosis. However, the risks of the unfavorable outcomes among overweight or obese children who became nonobese by adulthood were similar to those who were never obese [16].

Efforts have been made to explore the link between muscular fitness and health outcomes in youth, but the lack of high quality studies impedes extensive conclusions to be made. In a review by Ruiz et al. no conclusive statement could be made regarding the relation between muscular strength or motor fitness and cardiovascular disease risk factors due to the limited evidence[60]. However, they did find favorable links between muscular strength improvements with lower level of overall adiposity but less evidence of changes in central adiposity based on the review of four high quality studies [60].

The second most commonly evaluated health outcome of muscular fitness is bone health. Witzke and his colleagues showed direct positive relation between knee extensor strength and bone mineral content in their experiment study[61] and a few observational studies and a review study confirmed (however, different measures of musculoskeletal fitness were used) [62, 63, 48].

Finally, no substantial and consistent evidence has been found between flexibility and health outcome in youth [2]. One of the reasons for the lack of evidence is the difficulty in

quantifying specific joint flexibility measures with health indicators. In fact, excessive flexibility may actually increase the chance to be injured [64].

### **Prevalence of Youth Fitness**

The surveillance and tracking of youth fitness, particularly aerobic fitness and obesity, dates back to the 1930s. Historical studies have demonstrated that pediatric obesity has increased dramatically since the early 1970s globally [65]. A secular decline in aerobic fitness performance in 1970s was also found by Tomkinson et al. who reviewed data source from 33 studies published between 1958 and 2003 on 25,455,527 children and adolescents (6–19 years) from 27 countries in five geographical regions (i.e. Africa and the Middle-East, Asia, Australasia, Europe and North America) [66]. They claimed that performance was improving prior to 1970s but has been declining globally at the rate of about 5% each decade since then [66] .

In the United States, representative data on youth fitness are surprisingly scarce, especially after the mid 1980s [67]. Differences in test items administered from time to time make it difficult to compare the fitness test performance longitudinally. Several national youth fitness surveys were administrated from 1950s to 1980s (approximately once each decade). The American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) collected youth fitness in 1958, 1965, and 1975 from nationwide samples of school age children using AAHPERD Youth Fitness Test (AAHPERD YFT). Fitness performance did not change over time based on comparable test items from AAHPERD YFT, but the interpretation of the data must be made with caution because the testing procedure changed over time [68]. In mid-1980s, the President's Council on Physical Fitness and Sports (PCPFS) conducted National School Population Fitness Survey (NSPFS) from a nationwide samples of 18,857 children aged from 6 to 17 years old. Due to the extreme stringent assessment standards, the authors of the NSPFS



concluded, “not much change in physical fitness in American youth from 1975 to 1985 but the level of performance remains low” [69]. At the same time, the Department of Health and Human Services conducted another nationwide youth fitness survey with two phases: National Children and Youth Fitness Study (NCYFS) I assessed a representative sample of 8,800 children ages 10-17 years in 1984 [70], followed by NCYFS II assessed 4,678 children ages 6-9 years in 1987 [71]. Due to the variation in test items and methodology, it was not possible to make longitudinal comparisons with previous nationwide fitness testing; however, the study yielded similar conclusions - body fatness levels in youth were higher than their counterparts 20 years ago both from NCYFS I and II [72, 71]. In a review by Malina, 1 mile run/walk performance of American youth ages 7-17 years were compared from three national surveys (e.g., AAHPERD YFT, NSPFS, NCYFS) over an interval of 7 years. He reported that there is not much difference for both boys and girls ages 10 to 17 years old but children who were younger (age of 7-9 years old) had better performance from mid-1980s sample (NSPFS and NCYFS) than their peers from AAHPERD sample in 1979 [73].

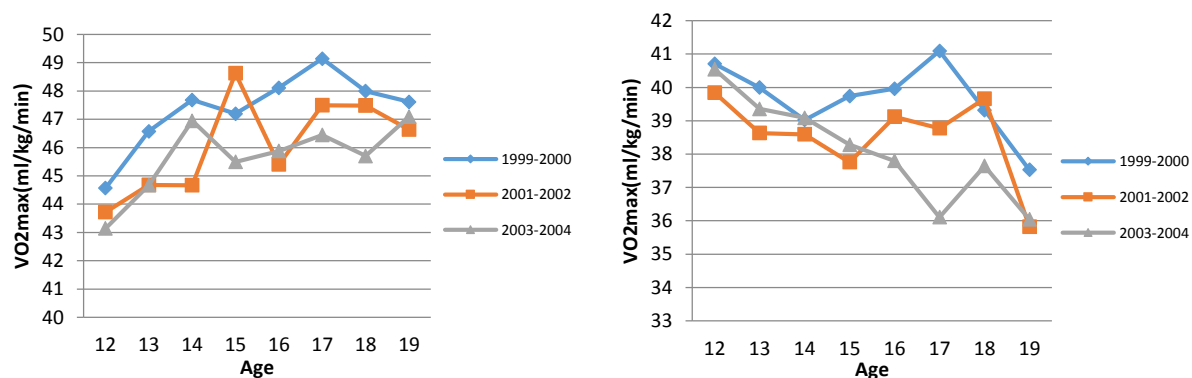
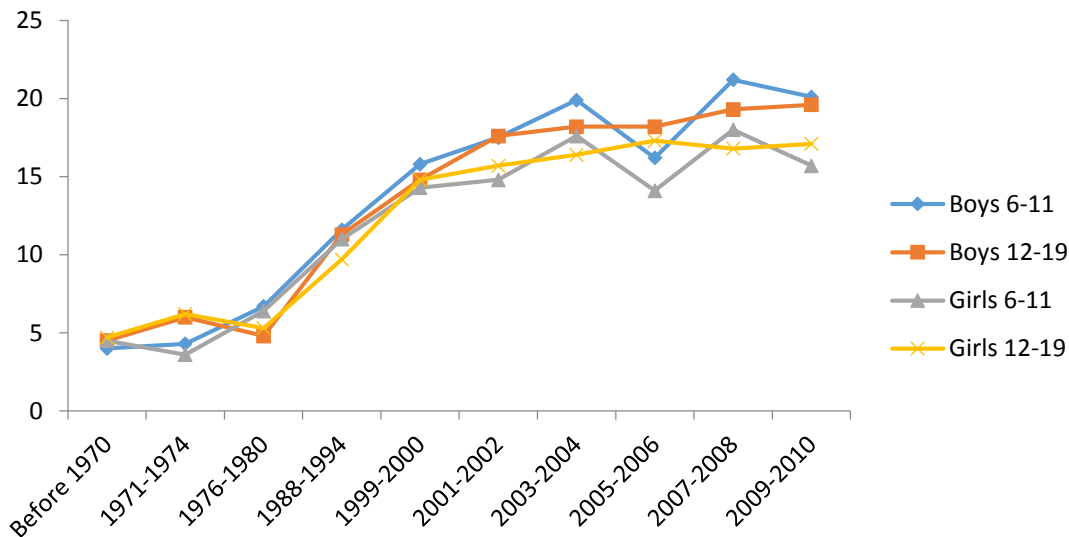


Figure 1. Secular changes of CVF fitness in boys and girls from NHANES data in 1999-2004.

A total of 3,622 boys and 3,583 girls from age 12 to 19 had their CVF fitness evaluated with a submaximal treadmill test as part of NHANES test protocol from 1999 to 2004 (CVF

fitness test item was abandoned after 2004) (Figure 1) [74]. The CVF fitness declined for boys across all ages. No differences were evident for girls at younger ages (12 to 14 years) but declines were also found in girls who were older than 14 years. No coordinated national youth fitness testing was conducted from the mid-1980s until 2012 when the Centers for Disease Control and Prevention launched the NHANES National Youth Fitness Survey (NNYFS). Data was released in September 2013 and further examination is needed to study the prevalence and secular changes of youth fitness.



*Figure 2. Secular changes of obesity among children and adolescents aged 6-19 years, by sex: United States, 1963-1965 through 2009-2010.*

The tracking of obesity levels among children and adolescents from nationally representative samples has been more systematic since the 1960s. Figure 2 shows progressive increases in obesity since 1976-1980 for girls and it was even earlier (since 1971-1974) for boys. Among children aged 6-11, obesity rates increased from 6.5% to 18.0% between 1976-1980 and 2009-2010, and it increased from 5.0% to 18.4% among adolescents aged 12-19 at the same

period. No significant increase in obesity rate was observed among girls between 1999–2000 and 2009–2010 but it was found among boys regardless of age.

### **Section Key Points**

- Cardiovascular fitness, body composition, musculoskeletal fitness, and flexibility are the main components in youth fitness
- Established evidence documents associations between both cardiovascular fitness and body composition and health markers in youth.
- Obesity prevalence in boys has increased but the trend is plateauing in the most recent decade.
- There is a lack of temporal trend in youth cardiovascular fitness.

### **Factors in Relation to Youth Fitness**

This section summarizes factors related to youth fitness achievement but special attention is placed on the school-based characteristics, policy variables and community built environment characteristics that impact population patterns of youth fitness. A summary of previous review studies is also provided to characterize the effectiveness of interventions on reducing the obesity prevalence and improving the cardiovascular fitness.

#### **The School PE and Health Policies and Practice**

Physical education (PE) in schools has been recognized as the most promising setting to educate youth about the importance of being physically fit and to provide the knowledge and skills needed to adopt an active lifestyle through their adulthood [75]. School policy and PE teacher characteristics play an important role in delivering this critical message to youth. The Centers for Disease Control and Prevention (CDC) has conducted the School Health Policies and Practices Study (SHPPS) every 6 years since 1994. The SHPPS study is the largest and most

comprehensive assessment of school health policies and practices and it provide unique insights at four different levels—State, school district, school, and classroom. It collects information on characteristics of school health in eight components (i.e., health education, PE and activity, health service, mental health and social services, nutrition services, healthy and safe school environment, faculty and staff health promotion, and family and community involvement). Nationally representative samples of school districts, public and private elementary, middle and high schools across all states are selected. Due to the focus of the study, the review only focuses on the results from PE and activity from the 2012 School Health Policies and Practices Study report[28]. From 2000 to 2012, the percentage of states and districts that required or recommended fitness testing in their PE program increased across different school levels. At the state level, 30.6% states required administering or using fitness testing in 2000, and the number increased to 61.2% in 2006 as well as 64.7% in 2012. At the district level, it increased from 49.8% in 2000 to 71.1% in 2012. Specifically, the percentages of districts that required or recommended schools use FITNESSGRAM increased from 12.8% to 36.5% for elementary schools, and similar patterns were observed for both middle and high schools (e.g., 9.5% to 40.2% and 8.3% to 40.3%). There is evidence that some policies regarding PE and PA have been strengthened in recent years. For instance, the percentage of districts that required mandated PE in elementary school increased from 82.6% in 2000 to 93.6% in 2012. However, the percentage of districts that allowed students to be exempted from PE for one grading period or longer for religious reasons declined from 32.4% to 16.7% in middle schools and from 33.8% to 13.7% for high schools between 2000 and 2012. In a further examination of SHPPS, Morrow et al. found that 65% of schools (out of 1,564) adopted and used fitness testing. PE teachers in secondary schools, those with degree in PE/kinesiology-related disciplines and those who had completed

staff development on physical fitness testing, were more likely to implement fitness testing than their peers [76]. In regard to PA programming, there was an increase in the percentage of districts that adopted methods to increase the amount of PE class time students are engaged in moderate-to-vigorous PA increased (32.6% to 55.1% between 2000 and 2012). However, few schools (3.8% of elementary schools, 7.9% of middle schools, and 2.1% of high schools) provided daily PE or its equivalent (150 minutes per week in elementary schools; 225 minutes per week in middle schools and high schools) for the entire school year (36 weeks) in 2012.

Another public health initiative, Bridging the Gap, also assessed the impact of policies, programs, and other environmental influences on adolescent PA, dietary habits, and obesity [77]. This multi-level initiative has collected information from school-based survey of high school seniors, school administrators, and other archival source. One finding from the Bridging the Gap initiative was that schools were more than four times likely to require 8<sup>th</sup> to have PE than 12<sup>th</sup> grades, which resulted in a dramatic drop off of student participation in PE from 8<sup>th</sup> to 12<sup>th</sup> grade [78]. Unfortunately, only a few studies have examined the influence of school PE policy and practice on student fitness level. Raschad et al. studied the effect of school level PE practice on approximately 5000 5<sup>th</sup> and 7<sup>th</sup> graders cardiovascular fitness and body composition. Results showed that eight school-level PE policies were significantly associated with cardiovascular fitness (collectively explaining 29.73% variance in cardiovascular fitness but only 4.53% in BMI) [25]. Another study examined school district-level compliance with state PE policy indicated that students in policy compliant districts had higher likelihood of meeting the aerobic fitness standard than those in non-compliant districts [26]. Moreover, some studies have explored the influence of school health policy and PE practice on youth obesity [24, 79]. O'Malley et al. did not find strong relation between the school PA environment and student BMI and they

concluded that the current practice in schools might not be impactful enough to produce distinguishable differences [79].

### **Community Built Environment in Relation to Youth Fitness**

Initial efforts to promote PA focused on either individual healthy lifestyle choices or community- and/or school-based support on structured exercise. However, the importance of built environment has been recognized as a critical determinant at both individual and population level PA promotion [80]. The built environment is a key contextual component in Ecological System Theory [81] which has been defined as “*a range of structural elements in a residential setting including housing, roads, walkways, density, transportation networks, shops, parks, and public spaces*” [82]. Globally, the reduction in the time-cost of food and increased modernization both contribute to the weight gain in population level [83]. Many intervention studies are now targeted to counteract these two environmental threats. Nutrient related and PA related built environment have been studied the most.

Two review papers particularly evaluated food environment on childhood obesity [84, 85]. Williams et al. [84] concluded that little evidence was found between food outlets (e.g., fast food restaurant, convenience store, supermarkets, and grocery stores) and food purchases or food consumption. However, some evidence was found between food outlet in relation to children’s body weight by Williams et al. after carefully reviewing 30 papers [84]. The cross-sectional design nature of most the studies caused possible neglect in confounding might undermine the internal validity of the results. In addition, the challenge inherent in diet related measurement might also introduce bias into the study. This food environment measurement limitation has also been discussed in another review article [85].

Another recent review article examined the only PA built environment and its relation with PA in youth. Ding et al reviewed 103 papers from which 86% were published between 2005 and 2009, indicating a dramatic increase of interest in built environment research during the past decade [86]. They found that the most consistent associations were reported from objectively measured environment characteristics and subjectively measured PA. The most frequently reported significant environment correlates were land-use mix and residential density for both children and adolescents. Additionally, walkability, traffic speed/volume, access/proximity to recreation facilities were also found significantly associated with PA in children from a substantial number of literatures [86].

Mixed results were reported from early systematic reviews in youth population of studies that reviewed both nutrition and PA related built environments [87, 88]. Methodological variation across different studies contributed to the lack of consistent finding. For instance, some studies used objective indicators (e.g., geographic data) while others used subjective measured indicators (e.g., parent- or child-reported) of the built environment as well as the PA measurement. With the improvement of built environment assessments (especially the use of geographic information system (GIS) spatial analysis methods), researchers have been able to draw more valid conclusions. A recent review conducted by Casey et al. [89] only examined the objective measured built environment and its relation to childhood obesity in 25 studies. Walkability is the most studied built environment feature and it has been found significantly associated with youth weight in 7 out of 9 studies. Accessibility to convenient store (3 out of 6 studies) and accessibility to recreational PA facilities (4 out of 9 studies) were also found to be significant built environment factors in relation to obesity. No consistent results were found among parks, other food retail outlets, restaurants with childhood obesity. Consensus seems to

have been reached among some of the built environment factors and childhood obesity prevention studies. Kumanyika et al. [90] conducted an intensive systematic review on 396 distinct studies from 600 articles that referenced policy and environmental strategies specifically for childhood prevention. They classified 24 nutrition and PA related strategies into four levels of ranking based on population-level intervention effectiveness. All of the tier 1 effective environmental and policy change intervention strategies were PA related, specifically: 1) School PA policies and environments; 2) Point-of-Decision prompts for PA; 3) Community design policy; 4) Street design policies; 5) Neighborhood availability of parks, playgrounds, trails and recreation centers. In addition, four out of thirteen nutrient-related strategies were identified as tier 2 effective, including 1) Government nutrition assistance programs; 2) Child care food and beverage policies and environments; 3) School food and beverage policies and environment; 4) Food pricing (schools and communities). The evidence led to strong conclusions about the importance of the built environment in a prominent 2011 Lancet Obesity Series [83]. The authors pointed out that the priority should be placed on reversing the nature of the obesogenic environment at the policies level, though there was also still support for individuals to fight against obesogenic environment should continue [83]. Thus, it is critical to better understand the complex pathway through which macro (e.g., environment and policy) and micro factors (e.g., individual and family) could influence the child obesity.

### **School-based Programs for Promoting Fitness in Youth**

Many school-based intervention programs have been implemented at school settings in the past decades. However, program effectiveness has varied and the magnitudes of effects have generally been small across different programs[91, 27, 92]. This review will mainly focus on the



program effects on body composition and cardiovascular fitness, but many other interventions have also targeted more general increases in PA.

An early meta-analysis by Harris et al. [91] reviewed the school-based PA intervention effect on BMI. This review included 18 randomized controlled trials with measured BMI and had interventions lasting at least 6 months (published before Sept 2008). They reported weighted mean difference of  $-0.05\text{kg/m}^2$  (95% CI:  $-0.19$  to  $0.10$ ) in BMI between control and intervention groups. Only 3 out of 18 reviewed articles reported significant improvement following PA intervention. In addition, no differences were found in further investigations on the quality, duration or other components (e.g. nutrition) of the intervention. Among 10 studies that reported other body composition measures rather than BMI, no consistent intervention effects were reported. The authors provided a number of possible explanations including 1). the dose of the PA introduced by the intervention programs was insufficient to change BMI as individual level of program adherence and objectively measured PA were missing; 2). the programs were only effective for children who had higher baseline BMI but effect was attenuated in population level measures; 3). other behaviors (e.g., dietary intake) had greater influence on body composition than PA.

Another meta-analysis of 19 papers conducted by Gonzalez-Suarez et al. published in the similar period (i.e., 2009) [93] found similar results with intervention programs producing small decreases in BMI compared to control group (weighted mean difference of  $-0.62$ ; 95% CI:  $-1.39$  to  $0.14$ ). However, they found that lower odds (OR=0.74, 95% CI=0.60 to 0.92) of being overweight and obese among participants in the intervention group than those were in the control group. Longer intervention duration was also found to be associated with lower OR. Conflicting results were published in a more recent meta-analysis review. Lavelle [29] reviewed 43

published studies from which they stated that overall 0.16 kg/m<sup>2</sup> decrease in BMI in children (95% CI: 0.06 to 0.25) and a more evident effect among overweight/obese participants (0.35, 95% CI: 0.06 to 0.25). The study found significant associations with BMI from both isolated PA interventions (-0.13, 95% CI: -0.22 to -0.04) and PA/nutrition combined interventions (-0.17, 95% CI: -0.29 to -0.06). Compared to the review conducted by Gonzalez-Suarez et al., Levelle et al. included newer studies and also adopted a looser inclusion criterion. The intervention duration expanded to at least 1 month instead of 6 months as in the previous meta-analysis [91]. The types of interventions were no longer constrained to PA related studies but rather combined PA and nutrition interventions studies (29 out of 43 studies) were evaluated. Surprisingly, only 9 out of 33 studies reviewed in previous meta-analysis conducted by Harris et al. [91] and Gonzalez-Suarez et al.[93] were included in Lavelle's study. The inconsistent inclusion criterion can also explain the discrepancies in the results.

In 2013, Dobbins published an updated comprehensive Cochrane database systematic review based on the '*school-based PA programs for promoting PA and fitness in children and adolescents age 6 to 18*' [27]. The 32 studies included in the review were RCTs with a minimal of 12 weeks intervention on BMI. A total of 8 studies (8/32) reported statistically significant outcomes in preventing BMI increase, with ranges from 0.1 to 1.0 kg/m<sup>2</sup> smaller increases in BMI for the intervention group compared to control group. There were clear similarities in these eight studies. For example, all of the 8 studies had interventions implemented at least 6 months and they all included changes in school curriculum and used printed materials. Four out of eight studies were implemented primarily by classroom teachers and two were provided by PE teachers[27].

Lastly, in the most recent meta-analysis Guerra et al. reported non-significant standardized means difference in BMI (-0.03, 95% CI: -0.09 to 0.04) between intervention and control groups[92] after reviewing 38 intervention studies conducted in school settings.

All in all, small and/or nonsignificant improvements in BMI among children and adolescents have been reported in most school-based programming interventions. The variations in intervention design may attenuate some of the effective intervention components. It is also possible that BMI is not a sensitive indicator of BC to the intervention but no consistent findings were reported for other BC indicators (e.g., skin-fold thickness, body fat mass, percent of body mass, and weight circumferences) [30]. However, some evidence suggested that combination interventions targeting both nutrition and PA are more effective in reducing weight among children and adolescents in school settings [94].

The interventions effects on cardiovascular fitness have not been studied as exhaustively as BMI, but several review articles evaluated the accumulated evidence. Different from BMI as the programming evaluation outcome, the majority of intervention studies appear to be effective in significantly improving cardiovascular fitness[27]. Kriemler et al. [45] reviewed RCT studies with a minimal 12 weeks duration published between 2007 to 2010, from which 11 studies were assessed cardiovascular fitness. Field tests (e.g., shuttle run and 6-minute run) measured cardiovascular fitness were used in the majority of studies (8/11). More than half of the studies reviewed (6/11) showed significant increases in cardiovascular fitness. The substantial dose of intervention in these studies (PE specialist led interventions with at least 45 minutes per sessions and five sessions/week) may have contributed to the success in the intervention. In the Cochrane collaboration review, Dobbins [27] included 6 eligible intervention studies that had measured cardiovascular fitness as an outcome. Four out of six studies found significant improvements in

VO<sub>2</sub>max estimates ranging from 1.6 to 3.7 ml/kg/min, except for one study that reported a lower heart rate. Five out of the six studies involved elementary school kids. All of the four significant intervention effective studies made changes to the school curriculum. In another recent review, Sun et al. [30] concluded that 6 out of 10 studies [53, 95-98] showed significant improvement in cardiovascular fitness among intervention groups. Four of the 6 studies with positive programming effectiveness were large, high quality (defined as having a low overall risk of bias) RCT studies. Surprisingly, no meta-analysis has been conducted with cardiovascular fitness as the programming outcome measure. However, the relatively consistent finding from the systematic reviews [30] [27, 45] suggest that school-based intervention have moderate programming effects on children and adolescents cardiovascular fitness.

Although some school-based PA intervention studies have proven to have some efficacy, few studies have shown utility when broadly disseminated [31]. The need to better translate research into practice has been widely advocated by the public health research community. Rabin et al. clarified several challenges in the process of translating efficacious intervention into practice[99] . One key issue is the balance between internal and external validity in studies. Most of the widely adopted RCT designs emphasize internal validity but this limits the generalizability to a broader population. Therefore, group randomized trials that favor external validity (i.e., quasi-experiment designs) are acceptable and even recommended as the organizational infrastructure and support cannot be reached at the individual level [100]. The RE-AIM (Reach, Efficacy, Adoption, Implementation, and Maintenance) framework [101] which includes evaluation of multistage and multilevel (i.e., individual and setting level) programming was also recommended to improve program evaluation and to increase the methodological rigor of studies. The evidence suggests that the ability to easily modify programs to fit demographic,

geographic and cultural contexts increase the likelihood of dissemination [102]. Thus, possible moderators and mediators such as contextual characteristics of adopters and providers were also encouraged to record in order to build better infrastructure to support the dissemination. Other strategies such as getting funding, increasing organizational commitment, encouraging research-practice partnerships, increasing organizational capacity, and providing adequate resources were also discussed. Furthermore, Owen et al. [100] summarized several pathways that may help evidence-based programs be more readily diffused. One of them is “direct to practice”, from which the intervention program/curricula is produced in a deliverable package or tool kit that either trained leader or instructors could deliver the program. Two of the well-known school-based PE programs-SPARK and CATCH were cited as examples of this pathway. A second pathway was described as ‘policy to practice’ in which adopters (e.g., schools) could implement a recommended program to comply with the established health-improvement policy [100].

### **Section Key Points**

- More states, districts, and schools required fitness testing in the past decade and PE policy has improved but the percentage of schools required daily PE remained low.
- A number of built environment characteristics have been identified associated with childhood obesity.
- School-based intervention programs are more effective in improving aerobic capacity than body composition.
- Unique considerations in research design and evaluation are needed to advance knowledge about program dissemination.

### **Overview of FITNESSGRAM**

FITNESSGRAM can serve as a public health surveillance tool and also be used to evaluate the intervention effectiveness. As a core measurement in all three dissertation studies, this section will focus on the history of FITNESSGRAM testing battery, summarize the specific

measures for different test components, describe the updates on the FITNESSGRAM criterion referenced standards, and review the prevalence of Healthy Fitness Zone (HFZ) achievement measured by FITNESSGRAM.

### **The History and Philosophy of FITNESSGRAM**

Plowman et al. [103] reviewed the history of FITNESSGRAM from its beginning to 2006. The details do not need to be repeated here but only the key highlights of evolution of FITNESSGRAM are reported here as well as the progress after 2006. According to Plowman et al. review, the conception of FITNESSGRAM® was introduced by Charles L. Sterling in 1977 when he recognized the interest in a physical fitness “report card” between school administrators and parents. FITNESSGRAM was first introduced as a reporting system in 1982 among 30 Tulsa schools with AAHPERD YFT and AAHPERD Health Related Physical Fitness Test were used as fitness testing battery[34]. Except for these two testing batteries published by AAHPERD, PCPFS developed President’s Challenge Program [104], which was an award system. FITNESSGRAM supported both two organizations and all three organizations collaborated in early 1980s. However, these multiple national testing batteries caused some confusion among practitioners and longitudinal surveillance was impossible among researchers and government. Several attempts had been made in mid-late 1980s among different councils and organizations to develop one unified national test. Unfortunately, no consensus was achieved and this resulted in the concurrent development of three national youth fitness test in late 1980s [34]. Charles Sterling initiated the meeting of the FITNESSGRAM ‘advisory committee’, who finalized the FITNESSGRAM test battery and award system in 1987. Members of the FITNESSGRAM advisory committee worked collaboratively to build an evidence-based health-related fitness assessment battery that utilized criterion-referenced standards. The standards were then

incorporated into an integrated software system to produce individualized FITNESSGRAM reports. In 1993, AAHPERD and the Cooper Institution agreed on a strategic partnership that FITNESSGRAM was designated the physical fitness and PA assessment, and software reporting system but Physical Best (another AAHPERD health related test published in 1988) became the education tool[103]. Later in 1999, an agreement established between the Cooper Institute and Human Kinetics publishers led to a partnership with Human Kinetics to market, publish, and distribute all FITNESSGRAM materials. By 2010, five states, including California (1996), New York City (2006), Texas (2007), Delaware (2008), and Georgia (2010), adopted FITNESSGRAM as their state mandated fitness testing battery. In December 2009, the NFL Foundation funded a three-year grant (which was renewed for another 3 years in 2012) with the the Cooper Institution to fund FITNESSGRAM in 1,120 schools under 32 NFL franchise. Each enrolled school was provided with free FITNESSGRAM license, FITNESSGRAM usage training, and access to PA promotion programming.

With years of communication, AAHPERD, CDC, Amateur Athletics Union, PCFSN, and the Cooper Institute facilitated a new unified collaborative program—the President’s Youth Fitness Program (PYFP) in September 2012. FITNESSGRAM was selected as the official fitness assessment tool in PYFP. Finally, more than half a century after the first U.S. national fitness test was published, a unified national youth fitness battery was developed with comprehensive staff development/teacher training, recognition (awards) system, scientific evidence-based assessment and evaluation structure, and computerized reporting system. For years, FITNESSGRAM has anchored programming to the HELP philosophy, an acronym that reflects the inherent notion that **H**ealth is available to **E**veryone for a **L**ifetime, and it is **P**ersonal. This has continued to be a driving philosophy in the program.

## Measures in FITNESSGRAM

### Aerobic Capacity (AC)

Three field tests are used in FITNESSGRAM to assess AC, including 15 or 20 meters Progressive Aerobic Cardiovascular Endurance Run (PACER) [105, 106], the one-mile run [107], and a walk test [108], among which PACER is the recommended test. Estimated VO<sub>2</sub>max is calculated using prediction equations developed separately for each field test method.

Reliability and validity (comparing with VO<sub>2</sub>max measured in the laboratory) of the three types of field tests were reported by numerous studies. The reliability of PACER in children and adolescents were moderate and high ranged from 0.64 to 0.93 [109, 105, 110, 111]. The content validity was high for PACER because it is a multistage progressive maximal exercise that replicates gold standard measure in the laboratory. The concurrent validity of PACER was also examined by numerous studies. The range of validity coefficient was from 0.51 to 0.9 in youth age 9-19 year [112-114, 105, 110, 115-119]. However, different predictors (e.g., age, sex, skinfold thickness, body weight) in addition to PACER laps were used to improve the accuracy in estimating VO<sub>2</sub>. In the most recent study, Mahar et al. found out that age/sex interaction and quadratic term of PACER laps were significant predictors in estimating VO<sub>2</sub>max [116]. The prediction equation used in the current FITNESSGRAM software for PACER is

$$VO_{2max} = 45.619 + (.353 * Laps) - (1.121 * age)$$

The reliability of one-mile run were similar with PACER, ranging from 0.53 to 0.91 in four previous studies [109, 120-122]. The content validity of one-mile run to estimate AC is based on highest rate of aerobic metabolism (VO<sub>2</sub>max) can be maintained in large part from long distance exercise, such as one-mile run [123]. The concurrent validity varied due to the variation in study population and characteristics, running skill and economy, effort given on the



test, and the environment condition. The content validity coefficient varied from -0.26 to -0.85 (only one study showed extremely low coefficient, -0.26) [120, 124, 107, 125, 121, 126, 127] .

The prediction equation used in the current FITNESSGRAM software for one-mile run is

$$Vo2max = .21*age*sex - .84*BMI - 8.41*time + .34*time^2 + (108.94)$$

The only study that has reported the reliability and validity of one-mile walk was conducted by McSwegin [128]. The intraclass correlation was 0.91 for reliability measured in 21 boys and girls in 14-18 years and the concurrent validity was 0.84 (compared with directly measured VO2max in 44 boys and girls) [128]. The prediction equation used in the current FITNESSGRAM software for one-mile walk is developed by Kline et al [108]:

$$VO2max = -.3877 (Age) + 6.315 (Gender) - .0769 (Weight) - 3.2649 (Time) - .1565 (bpm)$$

Due to difference in the test mechanism and development of the VO2max estimation equation, it is possible that the three test yield different classification in fitness. It is not recommend to directly compare the three assessments [129].

### Body Composition (BC)

Three field tests are used in FITNESSGRAM to assess body composition: BMI, skinfolds and bioelectric impedance analysis (BIA). In the current FITNESSGRAM, BMI was selected as the primary BC field test due to the widespread use of the BMI by the public health, medical and research committees. Densitometry (e.g., underwater weighing and air displacement plethysmography), imaging method (e.g., axial CT and MRI), and dual energy x-ray absorptiometry are considered as gold standards for assessing BC in youth [130] but are more complicated and expensive than BMI. The correlation between BMI and gold standard measures generally exceeds 0.5 (and is typically much higher) [131, 132] but the validity varies when it was used among population with different characteristics [133-136]. Thus, Moreno et al.

concluded that BMI is feasible to classify obesity status but performs poorly on predicting a certain individual's percentage of body fat [137].

For skinfold, triceps and calf are the two sites required to estimate percent of body fat in FITNESSGRAM. The FITNESSGRAM reference guide stated that only 3% to 4% standard errors of estimating body fat with skinfold method but the examiner needs to be well-trained [129]. In another study, Rodriguez et al. reported that the Slaughter equation using triceps and calf skinfolds had the best agreement in female adolescents comparing with DXA as the reference method [138]. Feasibility has been considered in spite of two sites of skinfold measures might not yield the most accurate estimation of BC.

BIA estimates body composition based on the physical principles of the Ohm's law that different body tissue components have different conduction rate of electrical current [139]. The validity and accuracy of BIA is comparable to skinfold method. Less training is required to use BIA to measure BC but the model of BIA devices, equations used in estimating body composition, hydration status of the participants all likely introduce some errors [139].

#### Muscular strength, endurance, and flexibility

Different muscular strength, endurance and flexibility field tests are used in school settings. A cadence-based curl-up is the primary test in FITNESSGRAM for abdominal strength and endurance. The 20 reps per minute pace refrains the students from bouncing, competing with peers, jarring, early fatigue, and the use of accessory muscles [140]. The reliability of curl-up test were higher for older adolescents ( $R=0.89$  to  $0.86$ ) [141] than younger children ( $R=0.70$ ) [142]. Although studies show adequate content and construct validity of curl-up test, the lack of proper criterion measure has led to limited concurrent validation evidence for the curl-up test. However,

the distinct variation between curl-up and sit-up tests indicate that these two field tests should not be used interchangeably.

Research has showed that the low back pain is significantly associated with trunk extensor strength [143]. Trunk lift is the recommended test in FITNESSGRAM for assessing trunk extensor strength and flexibility. The test-retest reliability ranged from 0.54 to 0.99 from intraclass correlation statistics and 0.20 to 0.89 from Pearson product-moment correlations [144]. However, the test-retest reliability is scarce in elementary aged children. Except for one study that reported high validity correlations ( $r=0.68$  in females and  $0.70$  in males) [145], the majority of validation studies used the multiple regression method and found that the trunk lift test explained very little variance in various laboratory test [146, 147]. Obviously, a more robust and valid trunk extension test is needed.

Considering the discriminating property of the test and equipment burden in school settings, the 90° Push-up test was recommended as the primary test for upperbody strength and endurance in FITNESSGRAM. Modified pull-up and flexed arm hang are the alternative test items. Several studies have evaluated the reliability of the Push-up and the results showed good to acceptable reliability. Correlation values have typically been above 0.80 for most of the studies with the values varying among different age groups (e.g., elementary, middle, and high school) [148-151]. Values were usually higher in teacher counted tests (compared to partners or peers) which may be due to the variability in objectivity and lack of recognition in correct forms from peer conducted tests. The Push-up test validity coefficients explained limited variance in muscular endurance criterion tests (16% -32%), but the results improved substantially (50% to 70%) after controlling for the body weight [151].

The back-saver sit and reach test served as the primary test item for flexibility. Shoulder stretch is the alternative test. The test-retest reliability of back-saver sit and reach was high and the intraclass reliability was between 0.96 and 0.99 in studies where children and adolescents were tested [152, 153]. A recent validation study compared field-based back-saver sit and reach test with hip (sacral), back (lumbar), and chest (thoracic) angles obtained with angular kinematic analysis. The results showed that 42%, 30%, and 4% variance was explained by hip, back, and chest angles, respectively, indicating that back-saver sit and reach can be a validate measure for hip and low-back flexibility[154].

Generally, there is a lack of concurrent validity evidence in muscular strength, endurance, and flexibility research. The challenges are due to the difficulty in criterion measure selection and isolating specific muscle group in both field test and criterion measures.

### **Standards of FITNESSGRAM**

Historically, norm-referenced standards have been used to evaluate youth physical fitness [155-158]. An evaluation decision based on norm-referenced standards involves comparing an individual's performance with a reference group (either a representative sample or all other individuals in the group). With the shift from performance-related to health-related fitness, it is critical to evaluate youth fitness related to health outcomes rather than rank a certain individual's fitness performance. The use of criterion-referenced standards (CRS) address this need because it evaluates levels of youth fitness based on absolute cut-off scores set between field fitness test measures and health outcomes [159-161]. The first CRS was introduced by Pate et al.[162] in the South Carolina Physical Fitness Test and the FITNESSGRAM Scientific Advisory Board developed the first CRS in one-mile run, %BF, BMI, back-saver sit and reach, sit-ups, pull-up, and flexed arm hang in 1987. It was developed based on empirical data, normative data, and

expert judgment from the panel of scientific advisors. Cureton et al. summarized the procedures of establishing and validating the CRS [163]. Although it became widespread use in late 1980s and well supported [164], it was developed based on the linkage between VO<sub>2</sub>max and adult mortality and chronic disease risk [163]. This was due to the lack of direct scientific evidence between aerobic capacity and health outcomes in youth as well as the lack of nationally representative data. In 2011, a major effort was made to develop new aerobic capacity and body composition CRS with NHANES data from 1999 to 2002 [165, 166]. A few of highlights of the new standards are summarized below:

- a. The relation between health outcome measures and criterion measure was established among youth. This was possible since studies have supported associations between aerobic capacity and cardiovascular disease risk factors [48, 45]. Due to the availability of NHANES data, direct relations were established between aerobic capacity and metabolic syndrome (tested positive in more than three of the five metabolic syndrome indicators, including weight circumference, blood pressure, fasting glucose, high-density lipoprotein cholesterol, and fasting triglycerides) in a large (n = 1,966) nationally representative sample of U.S. youth 12-18 years old [167-169].
- b. Instead of classifying the fitness performance into either “Needs improvement” (NI), or “Healthy Fitness Zone” (HFZ), the new standards introduced three categories of the evaluation: “Healthy Fitness Zone,” “Needs Improvement-Some Risk,” and “Needs Improvement-High Risk” (the term was slightly modified in 2013). The utility of Receiver Operating Characteristic (ROC) Curve ensured the cut-off values were selected based on the relative importance of sensitivity or specificity [170]. Emphasis was placed on sensitivity over specificity when establishing the low-fit (high risk) threshold to ensure

that the majority of children with metabolic syndrome would have the aerobic capacity level below this threshold that the “Needs Improvement-Health Risk” cut-off values were low enough. On the other hand, specificity was emphasized over sensitivity when setting up the cut-off values for high-fit (low risk), in which most of the children without metabolic syndrome would have aerobic capacity level above this threshold that the “Healthy Fitness Zone” cut-off values were high enough [168, 167].

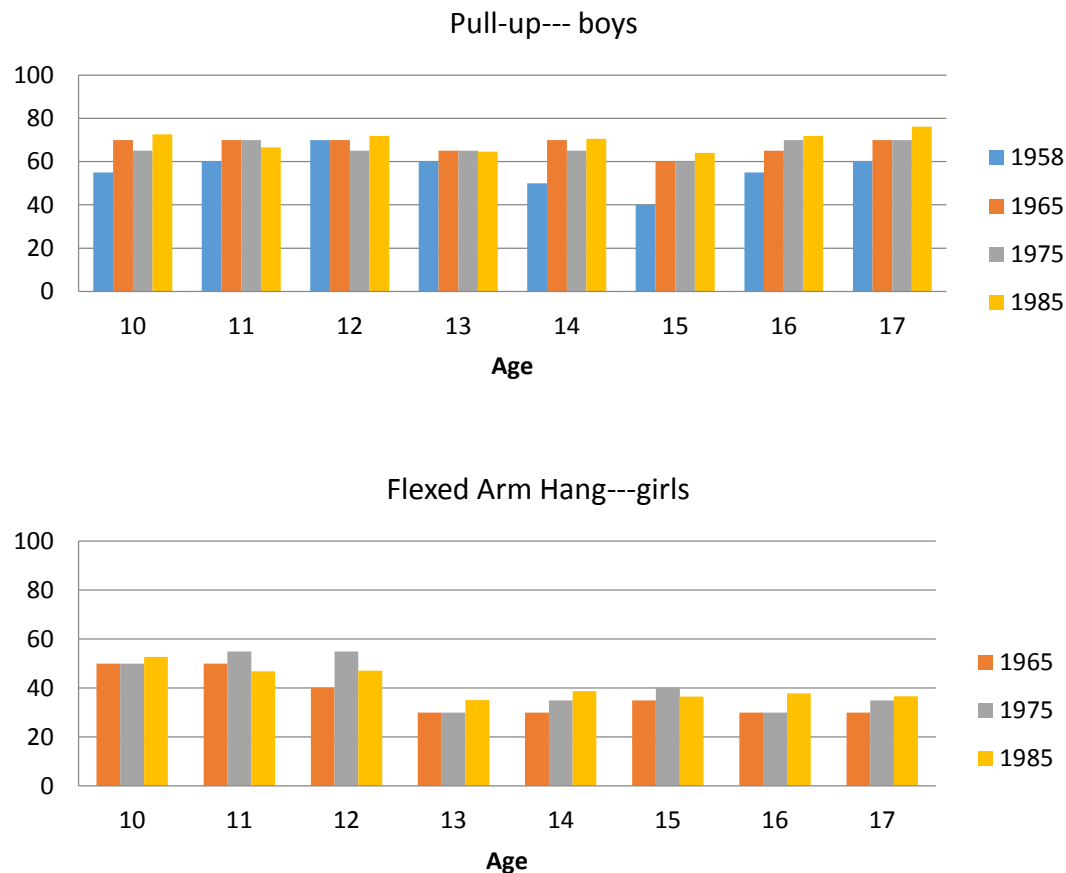
- c. Both aerobic fitness and body fat age- and gender-specific percentile curves were derived with LMS (L=skewness, M=median, and S=coefficient of variation) regression model [171, 172]. LMS derived Z score was used in the ROC method to control for growth and maturation in children and adolescents, which is much novel than the previous diagnostic criterion-referenced standards using ROC [164, 173, 174].

The new CRS are not without limitations. For instance, the small proportion of true positive cases (diagnosed with metabolic syndrome) would cause unstable cut-off values, more objective and scientific approach were applied to derive the new age- and gender- specific CRS for the two important fitness components. In a subsequent field evaluation of the new standards [175], the author pointed out that the comparing to the old standard, the new standard could “artificially” increase the HFZ achievement in young boys but slightly lower the percentage for older boys and girls at different ages. Therefore, it is important to not make direct comparison with different standards.

### **HFZ Achievement Status**

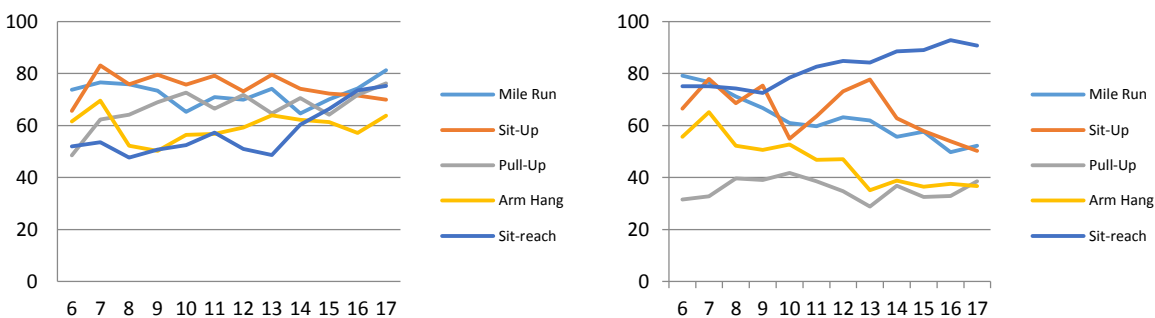
This section focuses only on the fitness status measured with FITNESSGRAM or secondary analysis applied with FITNESSGRAM standards. Group level HFZ achievement will be summarized and compared with different research findings. As mentioned earlier, test items

changed from different test battery as well as within FITNESSGRAM, which made the secular surveillance most difficult and impossible to draw valid conclusion about changes in youth fitness [176]. Corbin and Pangrazi summarized two items that most consistently tested from 1958 to 1985 among boys and girls aged 10 to 17 years, respectively, which were pull-ups (boys) and flexed arm hang (girls) [177] (figure 3). Unfortunately, raw data were not available except for NSPFS measured in 1985; however, norm tables (nearest to five percentile units) were available to make the crude comparison. The figure was derived based on the data from the Corbin and Pangrazi review published in 1992 [177].



*Figure 3. Secular changes of pull-up among boys and flexed arm hang among girls aged 10-17 years, United States, 1958-1985.*

Increases were observed from 1958 to 1965 for most of the ages except for age 12 in boys, and no decrease was evident between 1965 to 1985 for upperbody strength testing among boys and girls. One explanation for the increase from 1958 to 1965 could be the student familiarity of fitness testing. However, the level of passing the standards for girls in upperbody strength were extremely low. In the same paper, Corbin and Pangrazi also summarized the HFZ achievement in different test components from NSPFS tested in 1985 (figure 4) [177].

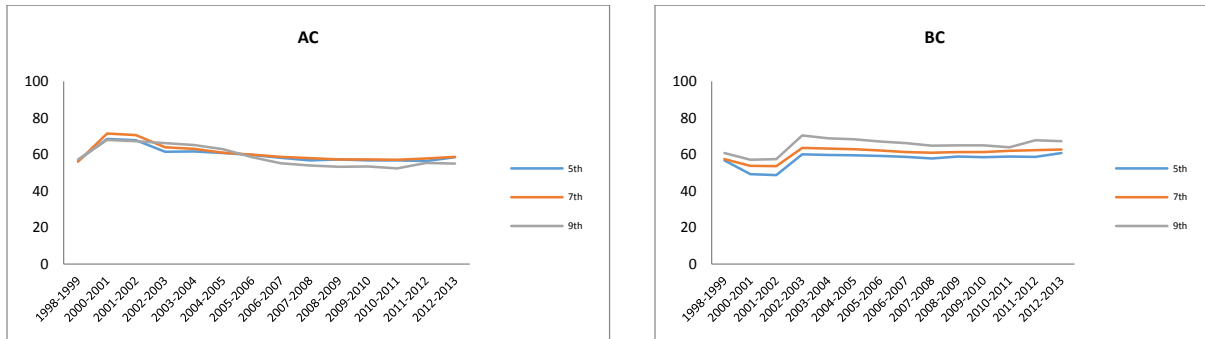


*Figure 4. Healthy Fitness Zone achievement in five tests among children and adolescents aged 6-17 years (boys-left, girl-right), NSPFS, United States, 1958-1985.*

Relatively low level of flexibility (e.g., sit and reach) among boys and upperbody strength and endurance (e.g., pull-up and flexed arm hang) among girls were reported. Age related decline was observed for girls in majority of the tests except for flexibility, but no evident decline was observed for boys[177]. The following statement from the NSPFS report (“still a low level of performance in important components of physical fitness by millions of children”) was extensively cited by media, however, numerous researchers pointed out that it was careless to conclude that American youth are unfit due to the lack of evidence support and inconsistent surveillance study [67, 176]. However, the innovative computerized reporting system provides the possibility of tracking the youth fitness in a longitudinal and large-scale approach. California



is the first state that adopted FITNESSGRAM as a statewide mandate as testing has been required in 5<sup>th</sup>, 7<sup>th</sup> and 9<sup>th</sup> graders since 1996.



*Figure 5. Healthy Fitness Zone achievement in AC and BC among 5th, 7th and 9th graders in California, United States, 1998-2013.*

The two figures above (Figure 5) capture fitness trends in AC (left) and BC (right) among boys from the California data collection system. The results showed a “mountain” shape between 2000 to 2002 and a slight decrease after 2002 in AC (this was more evident in 9<sup>th</sup> grade). On the contrary, a “valley” was observed between 2000 to 2002 and the trend is relatively level after 2002 for BC. In addition, higher grades had slightly higher HFZ achievement in BC. Both abdominal and trunk HFZ did not change much over years and little difference was seen among different ages. For upperbody, slight declines were evident except for 2006-2009, and it was more evident for 9<sup>th</sup> graders than younger peers. Lastly, visible declines were reported in flexibility across different ages and higher grade had higher achievement. Similar trends were noted in abdominal and trunk among girls. Opposite patterns in AC were seen from 2000 to 2002 among girls compared to boys with 9<sup>th</sup> grade girls having steeper declines in passing rates than younger girls. For BC, HFZ achievement leveled from 1998 to 2002, which fluctuated from 2002 until 2007 to reach the plateau. Girls showed evidence of constant decline after 2003 in

upperbody HFZ but slight declines in flexibility since 2000. It is important to note that the standards in AC and BC changed in 2010 which would cause artificial changes in HFZ trends.

In another statewide study, Welk et al. reported on 11,960 school-level FITNESSGRAM records from Texas. Age-related declines were also found in percentage of youth achieving AC standards for both genders but little evidence was found to support the decline in other fitness dimension [21].

### **Section Key Points**

- FITNESSGRAM has been established since 1977 and it keeps up with the updated research to serve the students, parents, schools, and other student health agency since then.
- PACER and BMI are the primary test items for aerobic capacity and body composition, respectively, in the current FITNESSGRAM.
- The updated CRS adopted in FITNESSGRAM first linked youth fitness with health (metabolic syndrome) with a national representative sample, provided strong scientific grounding to evaluate youth fitness.

### **Summary of Dissertation Related Studies**

This section summarizes the background and study design of two studies that will provide data for the proposed dissertation studies. The Texas Youth Fitness Study is a statewide fitness surveillance study and the NFL PLAY 60 FITNESSGRAM Partnership Project is a six year. participatory research study evaluating fitness and activity promotion strategies.

### **Review of Texas study**

According to the 2012-Shape of the Nation report, 19 states (e.g., California, Florida, Georgia, Illinois) required statewide fitness testing at either a certain grades or all grades in K-12 public schools. Texas is one of them. In 2007, Texas registration passed Senate Bill 530 as a state mandate to increase PA and fitness in public schools. FITNESSGRAM was selected by

Texas Education Agency as the fitness measurement tool. A total of 2,658,665 3<sup>rd</sup> to 12<sup>th</sup> grade students enrolled in the public schools tested using FITNESSGRAM battery in 2007-2008 academic year. More than 20,000 school teachers from 83% school districts and 70% school campus were trained and submitted data by June 1, 2008. A large project called the Texas Youth Fitness Study (TYFS) was launched to systematically evaluate the quality of teacher collected data, to establish the possible relation between fitness and academic achievement, and to determine the relation between teacher/school characteristics and fitness. The TYFS results compiled and published in a supplement to Research Quarterly for Exercise and Sport (RQES) [20]. This chapter summarized the key findings from TYFS, which established the scientific foundation to support the fact that trained teachers can collect valid statewide data for various surveillance purposes.

First of all, the prevalence of fitness was evaluated with FITNESSGRAM standards and the youth fitness discrepancies in different ethnicity and socioeconomic subgroups were also studied. The geographic variation in fitness profiles were also mapped with GIS. Welk et al. [21] did not find significant age-related HFZ achievement decline in majority of the fitness components except for aerobic capacity HFZ achievement which decreased from 70% in elementary schools to 46% in middle school and ended in 34% among high schoolers. Consistent with previous studies, students from low socioeconomic schools under performed in fitness but the pattern was less evident when using diversity as the demographic indicator. The use of GIS tools not only provided a better presentation for large-scale surveillance but expanded the possibility to further explore the complex interaction of demographic and environment characteristics on youth health. It is important to note that the prevalence of fitness in the TYFS

was evaluated with an old set of criterion standards that were changed in 2011. Therefore, direct comparisons with these outcomes are not possible.

One far-reaching conclusion from the TYFS is a controlled study that demonstrated that trained teachers can provide good reliability and validity of fitness data in real school settings with FITNESSGRAM testing protocol [23]. Teachers and expert team replicated fitness testing in two sets of matched schools 2 weeks apart, respectively. The test-retest reliability from teachers was high and comparable to expert team. The percentage of agreement ranged from 0.78 to 0.97 in teachers test-retest, which were even higher than expert team test-retested results (ranged from 0.77 to 0.96). The validity of tests was examined by two sets of comparison: 1) teacher administered vs. expert administered test on the same group of kids; 2) trained teacher administered vs. expert administered test. As a result, the validity (% agreement) of teacher administered test were above 0.7 except for curl-up and training improved validity substantially for one-mile run, PACER, and shoulder stretch. It is noteworthy that, with appropriate training, both reliability and validity of the testing improved. Concerns of weak results were expressed for some of the musculoskeletal items such as truck lift but the authors concluded that *“administrators, teachers, parents, and students can feel comfortable with the reliability and validity of the statewide health-related fitness testing in Teas”*.

The relationship between PE/school contextual characteristics and youth fitness (i.e., BMI and aerobic fitness) was also examined in the TYFS [22]. A survey about the school PE programs and policies was also sent out to 5,651 schools in the state. A total of 1,505 responses were compiled which provided rich information about 1) demographics information; 2) PE and recess frequency and duration; 3) resources/environment; 4) PE policies 5) experience/perception of fitness testing. Zhu et al. reported that a substantial percentage of teachers received a variety

of training (e.g., local school districts, DVD in manual, and videos) indicating the broad support from the state mandates. Nearly 90% of teachers were “very” or “somewhat supportive” of the state mandates fitness testing. In addition, high level of adherence (e.g., personally conducted the protocol, practice test, explain the procedure, encourage during the testing, and confidence in the results) to the testing protocol was reported. However, around 25% to 39% (elementary to high school) teachers reported negative student testing experience, which indicated the importance of lessening the comparison among students but focusing on the educational aspect of fitness in further fitness testing planning and in PE. In future analysis, Zhu et al. confirmed that teachers’ training, recess time, available PA space, a school wellness policy, and fitness testing practice were significant correlates of the aerobic fitness and BMI [22].

The Senate Bill 530 in Texas requires all K-12 state public schools to collect youth fitness data with FITNESSGRAM annually. Nearly 3 million of students were tested in 2010-2011 school years and the total number of students were reported to TEA fluctuated from 2011 to 2013. To systematically evaluate the secular youth fitness change, the Texas Education Agency issued a contract to the Cooper Institution in 2014 to analyze the statewide teacher submitted data. Because the FITNESSGRAM standards changed in 2010, only data from 2010-2011, 2011-2012, 2012-2013, and 2013-2014 academic years can be compared. De-identified individual data will be available for 2013-2014 academic year but only grade level data (i.e., percentage of students in the HFZ, NI) are available from previous years. Therefore, comparisons will not be possible with these data.

### **NFL PLAY 60 FITNESSGRAM Partnership Project**

The NFL PLAY 60 FITNESSGRAM Partnership Project is a research partnership between the NFL Foundation and The Cooper Institute that capitalizes on complementary assets

and a common vision of positively impacting youth PA behaviors. The Cooper Institute has been facilitating the objective assessment and promotion of health-related fitness for over 30 years through the FITNESSGRAM reporting system [178]. The NFL PLAY 60 campaign, in turn, has been providing schools with a diverse range of school fitness/PA promotion tools focused on a vision of helping youth to achieve 60 minutes of PA a day. The collaborative partnership has provided an integrated approach to help schools achieve the CSPAP vision. The collaboration also enabled us to establish a longitudinal research cohort to systematically examine the impact of the FITNESSGRAM and NFL PLAY 60 programming over time.

With funding from the NFL Foundation and active involvement from each NFL franchise, we have established a participatory research network that provides direct benefits to over 1100 schools (approximately 35 in each of the 32 NFL Franchises) while also informing best practices in school fitness assessment and promotion. Unlike most school-based studies, this project uses a participatory model to allow the impact of programming to be examined under more naturalistic conditions. The evaluation of factors influencing programming effectiveness is considered to be a key need for effective dissemination and translation [179]. To improve programming it is also essential to evaluate organizational processes influencing programming [180]. There are currently few examples of studies specifically designed with these goals in mind. The present paper summarizes the design and baseline characteristics of this innovative public health research project.

## **Design**

The NFL P60FGPP uses a unique participatory multi-level design to identify factors that influence the successful adoption and utilization of FITNESSGRAM (and associated NFL Play 60 Programming) in schools. Schools opt into the project voluntarily and directly coordinate

their own local programming with training and support provided by the CI project team. The systematic evaluation of school programming and outcomes provides insights about the level of training and support needed to most effectively promote youth physical activity and physical fitness. The nested nature of the design and associated evaluation plan is depicted in Figure 1.

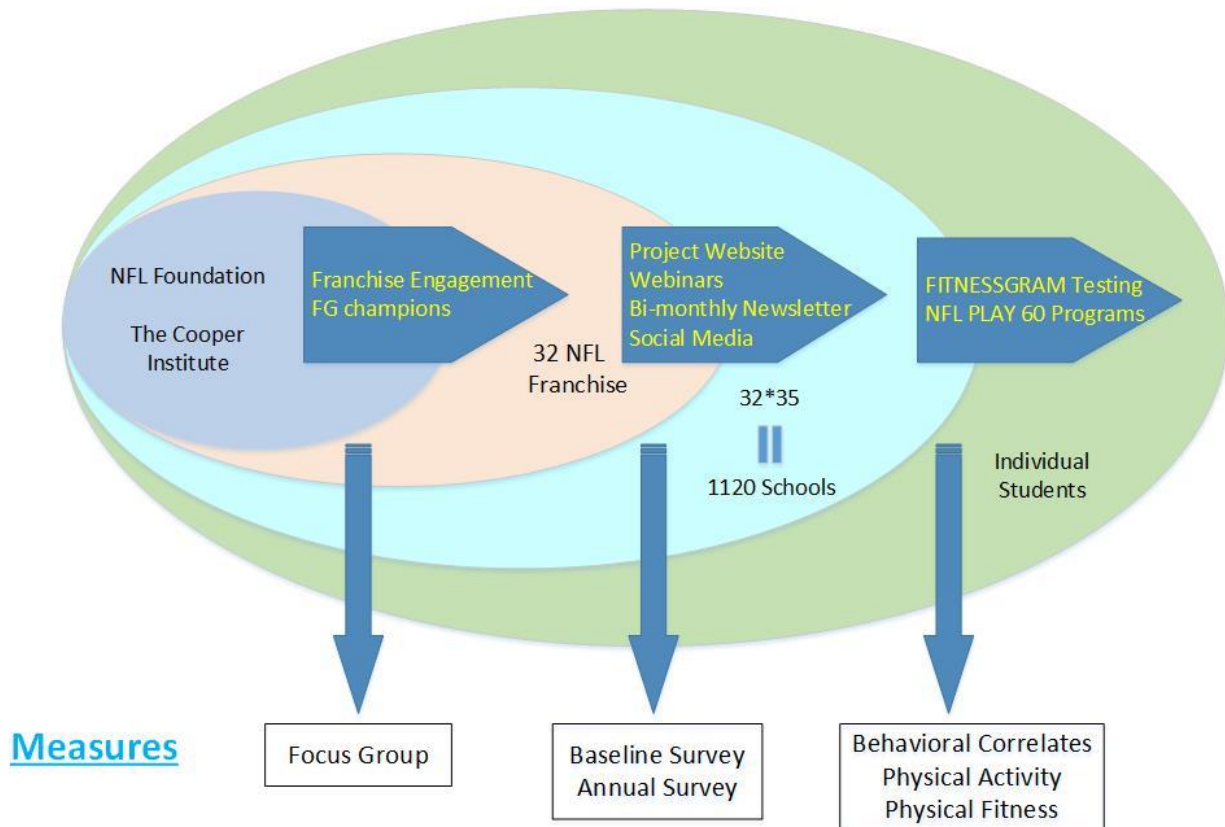
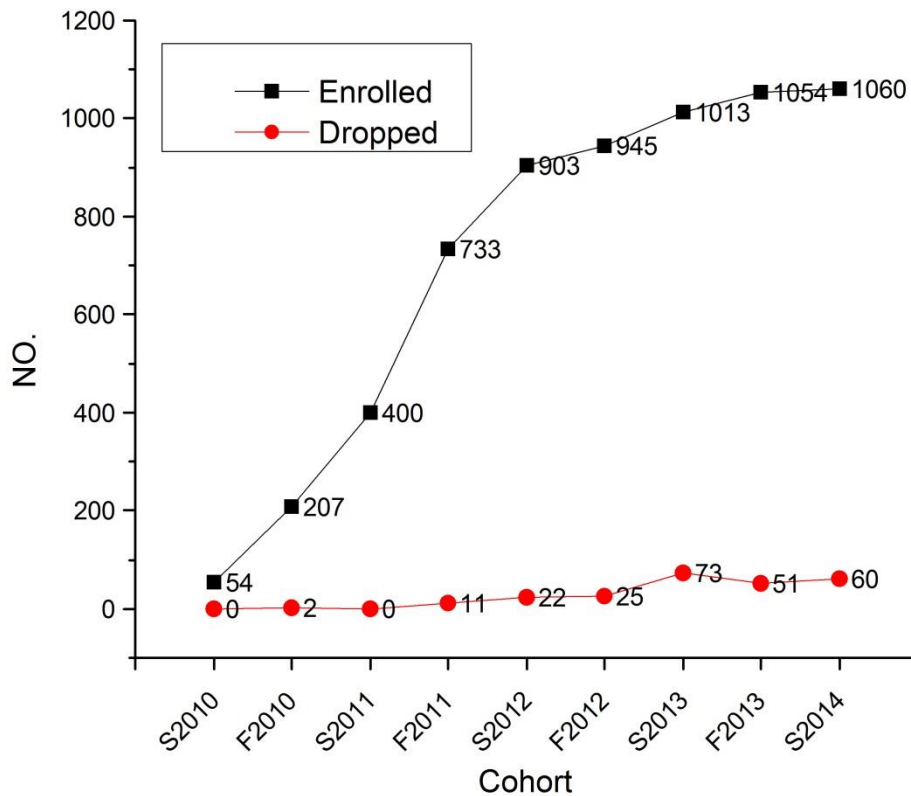


Figure 6. NFL PLAY 60 FITNESSGRAM Partnership Project design and measures flowchart

### Recruitment and Enrollment:

Recruitment of schools was completed in partnership with representatives from each of the NFL franchises and enrollment occurred in phases, which began in spring 2011 and concluded in spring 2014. Each of the 32 NFL franchises was provided with 35 site licenses to distribute to schools in their area. The recruitment was facilitated by the project team but

representatives from the participating NFL franchises coordinated and approved the contacts and assisted with recruitment in their local area. An advantage of this approach is that it generated interest and involvement of the individual franchises over time. The sequential increase in enrollment is shown in Figure 7.



*Figure 7. Number of site enrolled and dropped out at each cohort  
S:Spring; F:Fall; Enrolled: Number of schools enrolled in the project at each cohort; Dropped: Number of schools dropped the project at each cohort;*

Participating schools were provided with tangible benefits including free FITNESSGRAM site licenses and web hosting through the CI along with training and support. Teachers from participating schools were asked to complete a short online registration form to officially join the project. Following registration, a FITNESSGRAM test administration kit



(including a protocol manual) was mailed to the school and they were granted access to the web-based FITNESSGRAM application. Basic grant requirements included; completing a one-time baseline survey, conducting fitness testing twice a year (spring test: January 1<sup>st</sup> to June 31<sup>th</sup>; fall test: July 1<sup>st</sup> to December 31<sup>th</sup>), entering scores into the FITNESSGRAM software, completing an annual survey every spring, and sending home student fitness reports generated from the FITNESSGRAM software at least once a year. Participation in the project was voluntary and there was no cost for schools to participate; however, schools had to be willing to share de-identified data through the FITNESSGRAM software. The CI programming team provided guidelines on the effective utilization of FITNESSGRAM and NFL PLAY 60 resources (mainly Fuel Up to Play 60 and Play 60 Challenge) but, consistent with the participatory design, schools were provided with considerable freedom with regards to the degree of engagement and utilization of programming.

### **School Programming and Resources**

The programming was handled in two successive phases. The focus in Phase I was to build capacity to use the FITNESSGRAM program. Once schools demonstrated that they were able to complete and submit fitness results they were encouraged to work through the process of planning and implementing NFL Play 60 programs (Phase II). Schools were guided through the process in sequential cohorts and were allowed to proceed at their own pace. Brief descriptions of the FITNESSGRAM and NFL PLAY 60 program options are summarized below:

- **FG Training and resources:** Teachers were provided with a complete FG test kit including the standards chart, station signs, testing manual, stop watch, skinfold calipers and other testing resources. Teachers were provided a link for and encouraged to complete the free

online FITNESSGRAM training course. The course is based on the FG manual [178] and provides information about the program philosophy and testing protocol.

- NFL PLAY 60 Program Resources: The NFL PLAY 60 programs include a variety of resources for schools but the two predominant or featured programs emphasized in the project are described below:
  - PLAY 60 Challenge--funded by NFL Foundation, facilitated by American Heart Association. The Challenge is a four-week physical activity challenge that uses a physical activity tracking log and includes teacher guidelines and resources with physical activity suggestions. Additional information is on the web [http://www.heart.org/HEARTORG/Educator/FortheClassroom/NFLPlay60Challenge/NFL-PLAY-60-Challenge-Page\\_UCM\\_304278\\_Article.jsp](http://www.heart.org/HEARTORG/Educator/FortheClassroom/NFLPlay60Challenge/NFL-PLAY-60-Challenge-Page_UCM_304278_Article.jsp).
  - Fuel Up to Play 60 (FUTP60)--funded by National Dairy Council and NFL, and is facilitated by GENYOUTH. FUTP60 is a capacity building program that focuses on healthy eating and physical activity. Numerous resources are available for teachers and participating schools have the opportunity to apply for grant funding up to \$4,000 a year. Additional information is on the web <http://www.fueluptoplay60.com/>.

### **Communication and training**

The distributed nature of the project necessitated the exclusive use of electronic communication. Schools were provided with access to a detailed project website and were guided through programming with scheduled emails and newsletters, live webinars and E-learning modules. The initial correspondence encouraged all teachers to complete the online FITNESSGRAM training that included an overview of assessment philosophy and protocol.

This mode of communication is perhaps less intensive than in-person trainings or site-visits but it reflects a more realistic, cost-effective and sustainable strategy [181, 182]. An additional advantage is that the tools and resources developed through the project can ultimately be refined and disseminated to reach more schools. Other communication strategies have focused on promoting cohesiveness and coordination at the franchise level. Details on the key communication tools are summarized below.

#### Franchise level programming

- **FG Champions:** Local FG Champions were recruited from experienced and dedicated schools in each NFL market. The Champion teachers provide tangible local support and assistance to peer schools in their area. Champions were asked to contribute to the overall NFL P60FGPP goals, provide on-going mentorship to participants, and encourage sites to complete basic grant requirements. A stipend was provided for FG Champions that assumed the role.
- **NFL Franchise engagement:** Customized reports were provided to each of the 32 NFL Franchises to share information and provide recommendations for engaging with the local schools. The report provided information about degree of school participation and draft welcome/encouragement letters that could be sent. Suggestions were also provided about events and promotional opportunities that could be executed in their market.

#### School level programming

- **NFL PLAY 60 FITNESSGRAM Project website:** The project website provided an overview of the project, project team contact information, FITNESSGRAM assessment and software help documents, as well as parent and teacher resources. Website links to supportive organizations were also available.

- **Webinars and E-Learning Modules:** Various webinars and E-Learning modules were made available to project participants. Topics for these modules included project overview, step by step guidance through the FG software related to getting started with FG, accurately administrating the FG assessment, entering FG scores, and distributing reports to students.
- **Monthly newsletter:** Regular newsletters are distributed to highlight upcoming deadlines, updates or relevant stories concerning FG and NFL PLAY 60 as well as new resources, strategies and opportunities.
- **Social media (Facebook and Twitter):** FG Champions and project participants were encouraged to contribute to social media for the purpose of sharing relevant ideas with others. Social media presence varied and examples of posts included, clarification of fitness testing protocol, lesson plan ideas, and photos from school events that promoted physical activity and fitness among students.

Collectively, the resources and communication tools have increased interest and engagement in the project over time. Since the program launch there have been dramatic increases in school/site engagement as well as franchise engagement each year of the project.

### **Measures and Assessment**

The evaluation plan and selection of measures was guided by the use of the established Precede-Proceed Planning model [183]. The framework specifically led to the creation of a logic model that guided the selection of franchise, school and individual level measures. The franchise and school level measures correspond with the PRECEDE phase (Policy, Regulatory, Organizational Constructs in Educational and Environmental Development) and capture moderating variables designed to help explain differences in outcomes across the project (e.g.

school demographics, school/franchise engagement, teacher characteristics, fidelity of implementation etc.). The individual level measures capture the desired short, intermediate and long term outcomes associated with the PROCEED phase (Predisposing, Reinforcing, Enabling, Causes in Educational Diagnosis and Evaluation). The specific franchise, school and individual measures are summarized below.

- **Franchise-Level Measures:** The FG Champions and NFL contacts were encouraged to provide local support to all 35 sites in their market. Level of engagement and type of support varied between the Champions and NFL club contacts across all markets. Details are summarized below:
  - The FG Champions were assigned a level of engagement rating based on interaction with project sites and completion of assigned tasks. A 3-point scale was used to code engagement: Not Engaged (0); Moderately Engaged (1); Highly Engaged (2). Engagement was determined by whether or not the Champion submitted assigned tasks and contributed to school programming.
  - Each participating Club was assigned a level of engagement using a similar 3 point scale as the FG Champions. A 3-point scale was used to code engagement: Not Engaged (0); Moderately Engaged (1); Highly Engaged (2). Engagement was based on descriptive field notes recorded throughout the project using a Microsoft Access Process Tracking Database. Field notes included but were not limited to frequency of correspondence with NFL club contacts, discussions related to site incentives, and assistance with planning school level events.
- **School-Level Measures:** The teachers completed a baseline survey upon entry in the project to capture important school-level variables. Teachers also completed annual

surveys in the spring to report on the extent to which they followed the recommended programming guidelines and the extent with which they implemented NFL PLAY 60 programs. These are described below:

- Baseline Survey: The baseline survey is a 44 item electronic survey distributed to sites upon entry into the study. It was developed based on models from previous school-based projects [184] and on similar school policy/environmental surveys [185-187]. There were four main sections: (a) school and teacher demographics (11 questions), (b) school physical education and health policy (7 questions), (c) physical education programming and recess (10 questions) and (d) experience and perception of NFL PLAY 60 programs (16 questions). The survey is coded using state and school IDs to enable merging with other project-specific and geospatial mapping software.
- Annual Survey: The annual survey is a comprehensive assessment designed to collect information about school engagement and involvement in school programming during the year. The survey is distributed to sites in April every school year and covers five key aspects: (a) background information (4 questions), (b) compliance with (and perceptions of) FITNESSGRAM (20 questions), (c) compliance with (and perceptions of) NFL PLAY 60 programs (33 questions), and (d) teacher motivation and engagement items (10 questions). The annual tracking of these items captures the extent to which schools followed recommended practices and the extent to which they adopted and implemented NFL PLAY 60 programming.

- School Demographic Measures: School demographic variables were obtained from the National Center for Education Statistics (NCES) database (<http://nces.ed.gov/>). The key variables of interest included social economic status (SES), locale, minority rate, and enrollment. SES was calculated by percentage of students are eligible for free and reduced lunch. School locale was characterized using the following four categories: city, suburb, town, and rural. Minority rate was obtained as percentage of non-white students. Enrollment was obtained by grade within school building.
- **Student Measures:** The NFL PLAY60FGPP provided the training and support needed to promote physical activity and physical fitness in schools so the evaluation focuses on group level changes in student outcomes. The outcome measures include behavioral correlates of physical activity, self-reported levels of physical activity and comprehensive measures from the FG health related fitness battery. Details of the three measures are summarized below:
  - Behavioral Correlates (Youth Activity Correlates): The behavioral correlates scale included 20 items that collectively capture key constructs in the Youth Physical Activity Promotion (YPAP) model [188]. Revised versions of the Children's Attraction to PA scale [189] and the Perceived Physical Competence [190] were used to capture key Predisposing variables in the model. These scales have been used successfully in previous projects [191, 192, 189]. Recent work has demonstrated that the revised battery is invariant by age and gender and therefore suitable for longitudinal evaluations [193].

- Physical Activity (Youth Activity Profile): Children's involvement in physical activity is assessed using an online tool called the Youth Activity Profile (YAP). This 15 item instrument captures information about physical activity at school and at home as well as sedentary time. A unique feature of the instrument is that it has been calibrated to provide accurate group level estimates of time spent in moderate-and –vigorous physical activity (MVPA) and sedentary time in group of youth [194].
- Physical Fitness (FITNESSGRAM): Children's level of health related fitness is obtained from the established FITNESSGRAM battery [178] . Key measures include aerobic capacity, body composition, and muscular strength, endurance, and flexibility and these measures have been shown to have good reliability and validity for field based assessment [129]. All data were tracked using the coded individual ID numbers within the *FITNESSGRAM* software to maintain confidentiality.



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### **CHAPTER 3. MULTILEVEL ANALYSIS OF SCHOOL AND COUNTY CORRELATES ASSOCIATED WITH YOUTH BODY MASS INDEX**

#### **Abstract**

**BACKGROUND:** The social ecological model has been used at designing childhood obesity intervention programs and also provides a way to understand the childhood obesity disparity among children and adolescents from schools and neighborhood with different characteristics.

**PURPOSE:** The purpose of the study was to explore and quantify the differences in children and adolescent Body Mass Index (BMI) with a variety of school level, and county level characteristics.

**METHODS:** Nearly 2.5 million of children and adolescents BMI data were aggregated at the gender and grade level from more than 5000 schools were provided by Texas Education Agency.

School level predictors including enrollment and percentage of students qualified for free and reduced lunch (SES) were also provided by Texas Education Agency. Seven county level variables were obtained from County Health Rankings sub category measures including adult obesity, food environment index, adult physical inactivity, access to exercise, college completion, childhood poverty, income inequality. Multilevel modeling was used to examine the significant school and county level predictors to explain the variability in group level youth BMI.

**RESULTS:** The school level SES and enrollment have been identified as significant predictors in youth BMI for both boy and girls. The county level adult obesity, college

completion, childhood poverty and income inequality have significant associated with youth BMI among girls and the significant county level predictors for boys were food environment index and income inequality. Approximately 13% of the variations in BMI Healthy Fitness Zone achievement were due to the differences between counties. The predictors included in the present study explained about 60% of between county variation and 20-28 % of within county variation.

**CONCLUSIONS:** The results of the current study advanced the research in the correlates that are associated with youth obesity at both school and county levels that need to be taken into account when childhood obesity intervention are implemented and decision are made by policy makers.

## **Introduction**

The high prevalence of childhood obesity in the United States has been identified as one of the serious threat to public health for a number of years [1]. Public health efforts have emphasized the use of social ecological model to target the multiple and interconnected influences contributing to childhood obesity [2, 3]. Social ecological model generally postulate that health and wellness of human being are affected by multiple layers of influence that are generally categorized as individual, interpersonal, institutional, community, and societal level factors [4]. While generally used to guide intervention efforts, the social ecological model also provides a way to understand and explore the connections among these levels contributing to childhood obesity.

A key priority in public health research has been to better understand and reverse health disparities in the population [5]. A number of studies have evaluated correlates derived from individual and community in the social ecological model and their interacting influences on childhood obesity. One population demographic characteristic that has strong influence on youth obesity prevalence is parental socioeconomic status (SES) [6-8]. For instance, youth from high SES family have lower obesity prevalence than youth from middle and low SES families, and this is consistent across different races [6]. Neighborhood environment also plays a critical role on children and adolescents obesity. Several studies have examined the impact of different facets of neighborhood environments on child and adolescent weight status. Published empirical studies have identified a number of environment correlates of childhood obesity including heavy traffic [9], community safety [9-11], access to food outlets and grocery stores [12, 11], quality of fruits and vegetables [12] and quality and utilization of parks or playground [12, 11]. Generally, youth

who lived in safe neighborhood with access to park/playground and access to healthier food are more likely to be active and have normal weight.

The Center of Disease Control and Prevention recently proposed an expanded social ecological model called ‘Whole School, Whole Community, Whole Child (WSCC)’ to facilitate a collaborative approach between schools and community organizations to improve youth health [13, 14]. However, few studies have systematically examined the contextual influences from school and community variables on child health outcomes. The present study capitalizes on state-level data on child weight status available from the state mandated FITNESSGRAM youth fitness data collection in Texas to examine school and community influences. By combining FITNESSGRAM data with other available data sources it is possible to systematically explore and quantify the differences in children and adolescent weight status by school level, and county level characteristics.

## Method

### Study Population

Data for the present study were obtained through state mandated youth fitness testing that is required in Texas schools. The present study uses data collected by school teachers using the established FITNESSGRAM fitness protocols in the 2013-2014 academic year. Complete gender and grade aggregated fitness profiles were obtained through the Texas Education Agency (TEA) and the Cooper Institute but only group level Body Mass Index (BMI) data were provided. A total of 5,146 schools with BMI data were available for analyses from the TEA.

### Measures

*Outcome variable.* Height and weight were measured by school teachers and data were submitted to Physical Fitness Assessment Initiative application developed by TEA. The

application allows the calculation of BMI and data aggregation into the gender and grade level based on FITNESSGRAM version 9 standards described as following. Individual BMI data were evaluated with the FITNESSGRAM age- and gender-specific criterion-referenced fitness standards to determine whether an individual is in the Healthy Fitness Zone (HFZ), Needs Improvement Zone (NIZ), or Needs Improvement Health Risk (NIHR). The health-related standards were developed on the basis of body percent fat and its relation to the occurrence of metabolic syndrome [15, 16]. The resulting FITNESSGRAM version 9 standards were slightly different from the CDC childhood overweight and obese cutoff values but use the same centiles – The HFZ and NIHR cutoffs for boys were at the 83rd and 92nd percentiles while the corresponding values for girls are at the 80th and 90<sup>th</sup> percentiles [17]. The percentage of youth achieving BMI HFZ by gender and grade within each school was calculated as following

$$\text{BMI HFZ\%} = \frac{\text{Number of students BMI meet the standard in Xth grade by gender}}{\text{Total number of students measured BMI in Xth grade by gender}} * 100\%$$

*School level predictors (level 1).* School level enrollment and percentage of students that were qualified for free and reduced lunch data from 2013-2014 academic year were obtained from the TEA database. The free and reduced lunch indicator was used as a proxy measure of school SES. Age group was classified as elementary (1<sup>st</sup> to 5<sup>th</sup> grade), middle (6<sup>th</sup> to 8<sup>th</sup> grade), and high (9<sup>th</sup> to 12<sup>th</sup> grade) schools.

*County level predictors (level 2).* County level predictors were obtained from the most recent County Health Rankings data (<http://www.countyhealthrankings.org/>) [18]. Funded by Robert Wood Foundation, the County Health Rankings (CHR) compiled a wide variety of publically available data sources (e.g. Behavioral Risk Factor Surveillance System, National Diabetes Surveillance System, National Center for Health Statistics, American Community Survey) to compute ranks of health status every county within each state in U.S. The CHR

system uses four types of composite health factors (e.g., health behaviors, clinical care, social and economic factors, and physical environment) to systematically create county health profiles. The numbers of sub category measures vary for each of the four health factors. There are 9 measures under health behaviors (e.g., adult smoking and adult obesity), 7 measures under clinical care (e.g., preventable hospital stays and diabetic monitoring), 9 measures under social and economic factors (e.g., some college, children in social associations), 5 measures under physical environment (e.g., driving alone and severe housing problems)[19]. The selection of county level measures for the present study was made based on a literature review of past empirical studies and on theoretical justification for associations between subcategory measures and childhood obesity [20-23]. A total of seven subcategory measures were selected to use as the county level predictors in the present study, including adult obesity, food environment index, adult physical inactivity, access to exercise, college completion, childhood poverty, income inequality. Details of the measure and the associated data source from the CHR system is provided for each of the indicators. Adult obesity was reported as the percentage of adults that report a BMI of 30 or more using data obtained from the 2011 CDC Diabetes Interactive Atlas. The food environment index used a 0 (worst) to 10 (best) scale to evaluate factors that contribute to a healthy food environment, and the data source was 2012 USDA Food Environment Atlas and Map the Meal Gap. Physical inactivity assessed the percentage of adults aged 20 and over that reported no leisure-time physical inactivity and the data source was from the 2011 CDC Diabetes Interactive Atlas. Access to exercise opportunities captured the percentage of population with adequate access to locations for physical activity based on data from the 2011 and 2013 Business Analyst, Delorme map data, ESRI, & US Census Tigerline Files. College completion was scored as the percentage of adults ages 25-44 years with some post-secondary

education based on data from the 2009-2013 American Community Survey. Children in poverty reflected the percentage of children under age 18 in poverty based on the data from the 2013 Small Area Income and Poverty Estimates. Income inequality was calculated from the ratio of household income at the 80th percentile to income at the 20th percentile using data from the 2009-2013 American Community Survey.

Due to the different scales in each measure, all the measures were standardized to the same metric with a mean value of 0 and a standard deviation of 1. Reverse coding was already completed in the CHR system for some measures with higher scores indicating poorer health in the dataset for all county health ranking subcategory measures.

#### Statistical analyses

The analyses were designed to examine school and county level factors influencing childhood obesity. The data on BMI were aggregated by grade and gender at the school level but it was important to ensure that the sample submitted by each school is representative. Data were excluded if the submitted total number of students measured BMI was less than 10 for each grade and gender group per school. Data from 153 schools were eliminated due to this exclusion. Mean and standard deviation (SD) for percentage of BMI HFZ, NIZ, and NIHR, as well as the school level and county level predictors were calculated. SES and school enrollment data were centered and standardized at the school level for all multivariate analyses. School SES was multiplied by -1 that lower percentage of students qualified for free and reduced lunch represents high SES at school level. Standardized county level predictors were used in the various models .

Multilevel analytical approaches were adopted for the analyses due to both the hierarchical structure of the data (schools nested in the county) and our interest in examining the variation in school BMI HFZ achievement among different schools and counties. Age group was

treated as a categorical variable, but the remaining predictors were entered into the models as continuous variables. We used SAS PROC MIXED to conduct a series of hierarchical regression analyses with restricted maximum likelihood (REML) methods for the parameter estimation. We let  $Y_{ij}$  denote the BMI HFZ% of the  $i$ th school located in the  $j$ th county. Regression parameters  $\beta_{ij}$  ( $i=1, \dots, p$ ) were fixed effect coefficients at the school level (level-1). Regression parameters  $\gamma_{ij}$  ( $j=1, \dots, p$ ) were fixed effect coefficients at the county level (level-2). Residuals  $r_{ij}$  and  $\mu_{ij}$  ( $i=0, 1, \dots, p$ ) were the random effects of the model. All the models were tested separately for girls and boys and the significant level was 0.05. The Akaike information criterion (AIC) was used to compare the fit of the models. The six nested models were described as follows.

#### Model 1: Unconditional Means Model

We started with the unconditional means model to estimate how much the school level BMI HFZ achievement was due to the dependence from the county effect. We assume that within each county, BMI HFZ follows a normal distribution with a county-specific mean,  $\beta_{0j}$ , and a variance,  $\sigma^2$ . Moreover, we assume that the county-specific means follows a normal distribution with mean,  $\gamma_{00}$ , and variance  $\tau_{00}$ .

$$Y_{ij} = \beta_{0j} + r_{ij} \quad 1a$$

$$\beta_{0j} = \gamma_{00} + \mu_{0j} \quad 1b$$

Combining the two equations into one, we have

$$Y_{ij} = \gamma_{00} + \mu_{0j} + r_{ij} \quad 1c$$

Equation 1a is the level-1 model which represents the variability of BMI HFZ achievement within each county, whereas Equation 1b is the level-2 model representing the variability between counties.

#### Model 2: Examining effects of School Level (level-1) predictors



In this model, we explored the school level predictors SES, enrollment, and age group effects on the variation of mean BMI HFZ achievement. All of the school level predictors were treated as fixed effects in the model.

$$Y_{ij} = \beta_{0j} + \beta_{1j}(\text{SES}) + \beta_{2j}(\text{Enrollment}) + \beta_{3j}(\text{Age group}) + r_{ij} \quad 2a$$

$$\beta_{0j} = \gamma_{00} + \mu_{0j} \quad 2b$$

Combing the two equations into one, we have

$$Y_{ij} = \gamma_{00} + \gamma_{10}(\text{SES}) + \gamma_{20}(\text{Enrollment}) + \gamma_{30}(\text{Age group}) + \mu_{0j} + r_{ij} \quad 2c$$

Model 3: Examining effects of School Level (level-1) predictors with random effect of SES

Model 3 was built on Model 2 but the random effect of SES was added. The random effect of SES was excluded if there was no improvements in model fit as illustrated by changes in AIC.

$$Y_{ij} = \beta_{0j} + \beta_{1j}(\text{SES}) + \beta_{2j}(\text{Enrollment}) + \beta_{3j}(\text{Age group}) + r_{ij} \quad 3a$$

$$\beta_{0j} = \gamma_{00} + \mu_{0j} \quad 3b$$

$$\beta_{1j} = \gamma_{10} + \mu_{1j} \quad 3c$$

Combing the three equations into one, we have

$$Y_{ij} = \gamma_{00} + \gamma_{10}(\text{SES}) + \gamma_{20}(\text{Enrollment}) + \gamma_{30}(\text{Age group}) + \mu_{0j} + \mu_{1j}(\text{SES}) + r_{ij} \quad 3d$$

Model 4: Examining effects of School Level (level-1) predictors with random effect of SES and enrollment

Model 4 was built on Model 3 but the random effect of enrollment was added. If the model fit doesn't improve, the random effect of enrollment will be excluded.

$$Y_{ij} = \beta_{0j} + \beta_{1j}(\text{SES}) + \beta_{2j}(\text{Enrollment}) + \beta_{3j}(\text{Age group}) + r_{ij} \quad 4a$$

$$\beta_{0j} = \gamma_{00} + \mu_{0j} \quad 4b$$

$$\beta_{1j} = \gamma_{10} + \mu_{1j} \quad 4c$$

$$\beta_{2j} = \gamma_{20} + \mu_{2j} \quad 4d$$

Combing the four equations into one, we obtained

$$Y_{ij} = \gamma_{00} + \gamma_{10}(\text{SES}) + \gamma_{20}(\text{Enrollment}) + \gamma_{30}(\text{Age group}) + \mu_{0j} + \mu_{1j}(\text{SES}) + \mu_{2j}(\text{Enrollment}) + r_{ij} \quad 4e$$

Model 5: Examining effects of both county (level-2) and school level (level-1) predictors

In this model, we explored the effects of the seven county level predictors (i.e., adult obesity, food environment index, physical inactivity, access to exercise opportunities, some college, children in poverty, and income inequality) on the variation of BMI HFZ achievements.

$$Y_{ij} = \beta_{0j} + \beta_{1j}(\text{SES}) + \beta_{2j}(\text{Enrollment}) + \beta_{3j}(\text{Age group}) + r_{ij} \quad 5a$$

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Adult obesity}) + \dots + \gamma_{07}(\text{Income inequality}) + \mu_{0j} \quad 5b$$

$$\beta_{1j} = \gamma_{10} + \mu_{1j} \quad 5c$$

$$\beta_{2j} = \gamma_{20} + \mu_{2j} \quad 5d$$

Combing the four equations into one, we have

$$Y_{ij} = \gamma_{00} + \gamma_{10}(\text{SES}) + \gamma_{20}(\text{Enrollment}) + \gamma_{30}(\text{Age group}) + \gamma_{01}(\text{Adult obesity}) + \dots + \gamma_{07}(\text{Income inequality}) + \mu_{0j} + \mu_{1j}(\text{SES}) + \mu_{2j}(\text{Enrollment}) + r_{ij} \quad 5e$$

Model 6: Examining effects including both county (level-2) and school level (level-1) predictors and cross-level interaction

In this model, the significant county level predictors were added into the slope of SES and enrollment estimation to test the significance of cross-level interaction term.

$$Y_{ij} = \beta_{0j} + \beta_{1j}(\text{SES}) + \beta_{2j}(\text{Enrollment}) + \beta_{3j}(\text{Age group}) + r_{ij} \quad 6a$$

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Adult obesity}) + \dots + \gamma_{07}(\text{Income inequality}) + \mu_{0j} \quad 6b$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}(\text{significant county level predictor}) + \dots + \gamma_{1p}(\text{significant county level predictor}) + \mu_{1j} \quad 6c$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21}(\text{significant county level predictor}) + \dots + \gamma_{2p}(\text{significant county level predictor}) + \mu_{2j} \quad 6d$$

$$\beta_{3j} = \gamma_{30} + \gamma_{31}(\text{significant county level predictor}) + \dots + \gamma_{3p}(\text{significant county level predictor}) \quad 6e$$

Combining the four equations into one, we have

$$\begin{aligned} Y_{ij} = & \gamma_{00} + \gamma_{10}(\text{SES}) + \gamma_{20}(\text{Enrollment}) + \gamma_{01}(\text{Adult obesity}) + \dots + \gamma_{07}(\text{Income inequality}) + \\ & \gamma_{11}(\text{significant county level predictor}) * (\text{SES}) + \dots + \gamma_{0p}(\text{significant county level} \\ & \text{predictor}) * (\text{SES}) + \gamma_{21}(\text{significant county level predictor}) * (\text{Enrollment}) + \dots + \gamma_{2p}(\text{significant} \\ & \text{county level predictor}) * (\text{Enrollment}) + \gamma_{31}(\text{significant county level predictor}) * (\text{Age} \\ & \text{group}) + \dots + \gamma_{3p}(\text{significant county level predictor}) * (\text{Age group}) + \mu_{0j} + \mu_{1j}(\text{SES}) + \\ & \mu_{2j}(\text{Enrollment}) + r_{ij} \end{aligned} \quad 6f$$

To further explore the significant cross-level interactions, plots of predicted BMI HFZ achievements were created on the basis of high vs low level of school (age group is not considered as it was a categorical variable) and county predictors, respectively. The high and low level of county indicators were determined based on being above 1 SD or below -1 SD, respectively. The high and low level of school indicators were determined based on whether they were above or below zero, respectively.

## Results

The final sample included in the present study included 1,399,286 boys aggregated into 14,571 grades and 1,121,440 girls aggregated into 14,331 grades from a total number of 4,993 schools across Texas. Out of 254 counties in Texas, our study included 214 counties of youth. Descriptive results showed that 56.5% girls and 52.2% boys achieved the BMI HFZ, 10.5% girls and 13.9% boys in the NIZ and approximately 33% children and adolescents in BMI NIHR in Texas (Table 1). The mean and Standard Deviation (SD) of all school and county level variables are summarized in Table 2.

### *Girls*

### Model development

Table 3 reported the results of hierarchical regression analysis from Model 1 to Model 6 among girls. The Intraclass correlation coefficient (ICC) for girls was calculated from Model 1 as 0.13 indicating that 13.0% of the variation in average BMI HFZ achievements was due to variations between counties while 87% of the variation was due to the variability between individual schools. Model 2 demonstrated that SES, enrollment, and age group were significant school level predictors in estimating the variation in BMI %HFZ achievement means. The conditional ICC is 0.10, which indicated that 10% variation is due to dependence among schools within the same county after controlling for school level predictors. Model 3 and 4 tested the random effects of school level factors SES and enrollment separately on BMI HFZ achievements. The model fit was also improved in Model 3 and 4 based on the AIC (that the random effects of SES and enrollment remained in the following models). Model 5 added the seven county level predictors in the model. Adult obesity, college completion, childhood poverty, and income inequality were found to be significant county level predictors with school level indicators of SES, enrollment, and age group remaining significant. Thus, twelve interaction effects were added in the Model 6 on the basis of Model 5. Compared to the null Model, 61% of between county variation and 28.4% of within county variation can be explained by Model 6.

### Main effects interpretation

In Model 6, the significance of county and school level predictors did not change and two of the interactions, college completion\*enrollment and adult obesity\*middle school were significant. An increase of 1 SD of standardized SES resulted in 6.62% more girls classified in the HFZ while similar effect from enrollment was associated with 0.99% more girls in the HFZ.

Compared to elementary schools, middle schools had 3.10% fewer girls classified in HFZ and high schools had 3.06% more. With respect to county health, a 1 SD increase of county level adult obesity rates (2.1%) had 0.77% fewer girls in the BMI HFZ. Counties with more than 1 SD higher college completion rates (10.2%) had 1.50% more girls in HFZ. Similar interpretations can be made to the significant county variables of childhood poverty and income inequality.

#### Cross-Level interactions interpretation

The cross-level interactions of adult obesity\*high school was also significant. This can be interpreted as follows: In counties with more than 1 SD higher obesity rates (2.1%), 0.60% more middle school girls were classified in HFZ than elementary girls. Figure 1 illustrates the interaction effects of college completion and enrollment on girls BMI HFZ achievements. Girls in the counties with more adults completed college degree had higher BMI HFZ achievements regardless of the size of schools they attended. In counties with higher adult college completion rates, girls attending larger schools had higher BMI HFZ achievements than those who attended smaller schools. In contrast, in counties with low college completion rates, girls attending smaller schools had higher BMI HFZ achievements. Overall, the effect size of cross-level interaction terms is small and limited between and within county variances were explained by interactions.

#### ***Boys***

##### Model development

The parallel results of the hierarchical regression analyses predicting BMI HFZ among boys (Model 1 to Model 6) are presented in Table 4. The ICC calculated from Model 1 was 0.13 which means that 13% of the variations in BMI HFZ achievement means among boys can be attributed to variations between counties with 87% of variations explained by the variability

among individual schools. School SES, and school enrollment were significant school level predictors in explaining the variation in BMI HFZ from different schools. Middle school boys had significantly different BMI HFZ than elementary school boys. The model fit improved in Model 3 and 4 after adding the random effects of SES and enrollment, respectively. Thus, the random effects of SES and enrollment were retained in the subsequent models. After adding seven county level predictors into Model 5, food environment index, college completion, and income inequality were significant county level indicators. School level indicators SES, enrollment, and age group remained significant. As a result, nine interaction terms between significant county and school level predictors were added in the Model 6 and the model fit improved according to the AIC indicators. Thus, Model 6 was selected as the final model. In addition, 61% of between county variation and 20.0% of within county variation in the null model were explained by Model 6.

#### Main effects interpretation

Compared to Model 5, enrollment was no longer significant in Model 6 but the rest of the school and county level predictors were still significant. More specifically, an increase of 1 SD in student SES was associated with 4.61% more boys classified in BMI HFZ. Compared to elementary school boys, 1.38% less middle school boys were in the HFZ. In terms of county health predictors, a 1 SD larger score on the county level food environment index (1.1) was associated with 1.27% higher percentages of boys achieving the BMI HFZ. College completion rates less than 1 SD below the mean (~10.2% fewer adults with college degrees) was associated with 0.91% fewer boys in HFZ. Similar to girls, counties with income inequality more than 1 SD above the mean (~ 0.7) had 2.12% fewer boys classified in the HFZ.

#### Cross-Level interactions interpretation

The interaction of college completion\*SES, food environment index\*enrollment, college completion\*high school, and income inequality\*high school were also significant. For boys in counties with obesity rates more than 1 SD above the mean (~17.9% more obese adults), there were 1.11% fewer high school boys in the HFZ than elementary school boys. Similarly, for boys in counties with income inequities more than 1 SD higher than the mean there were 1.73% more high school boys in the BMI HFZ than elementary school boys. Regarding the random effects, all of the random effect in the different models were significant indicating that there are still within county and between county variations in BMI HFZ achievements that are not explained.

The two interaction effects of college completion\*SES and food environment index\*enrollment among boys were displayed in Figure 2 (a) and (b). The difference of BMI HFZ achievements between counties with high and low college completion rates was greater for boys from high SES schools than for boys from low SES schools. There was a greater difference in BMI HFZ between high and low SES schools for boys in the high college completion counties than there was for boys in the low college completion counties. The difference of BMI HFZ achievements between counties with high and low food environment index was greater for boys from larger schools than for boys from smaller schools. Boys from large and small schools had similar BMI HFZ in low food environment index counties but boys from larger schools had considerably higher BMI HFZ than boys from smaller schools in high food environment index counties. Overall, the effect size of cross-level interaction terms is small and limited between and within county variances were explained by interactions.

## Discussion

The study explored factors at both school and county level that were associated with child and adolescents weight status to advance understanding of disparities in weight status. We demonstrated that overall variation in BMI HFZ achievements among Texas K-12 students was due to both between-county and within-county variation, with the majority of variation due to school level variabilities. We also identified several school and county level correlates that predicted the youth weight status.

The study confirmed that SES is a strong predictor of children obesity, especially at the group level. There appears to be a consensus that children and adolescents with low SES background tended to have higher prevalence of obesity than their peers from a high SES background regardless of which indicator was used as proxy measure of SES or whether the SES was measured at individual level or group level [24-26]. In a recent study conducted by our research group, we deliberately examined the combined and independent effect of school level SES and minority prevalence on youth fitness. SES measured by percentage of students qualified for free and reduced lunch was found to be the most influential school level variable in predicting the youth fitness disparity within schools. Another school level characteristic evaluated in our study was the school enrollment since it is possible for programming and support to vary in big or small schools. The results showed that larger school tended to have higher BMI HFZ achievement than smaller schools. Few studies have examined how school size could influence students weight but a number of studies found that school size was related to schooling outcomes, including academic achievement, extracurricular participation, student satisfaction and attendance [27, 28]. Based on the present findings it is possible that the effects of



school size on academics may be mediated in part by associated differences in weight status since studies have shown BMI to be associated with academic achievement [39].

The other unique aspect of the present study is that we simultaneously examined how county level factors influence the group level BMI and the interaction effects between county and school level factors. Although a smaller portion of variation in BMI HFZ was due to the difference among counties, the overall county health level indicators we included in our study explained approximately 60.0% of the overall between county variations. Among 7 of the county level variables, adult obesity, food environment index, college completion, and income inequality showed as significant predictors in estimating the overweight/obesity. It is well documented that overweight and obese youth are more likely to become overweight/obese adult since early 1990s [29-31]. It may be due to the extension of obesity-related unhealthy behaviors, such as the modifiable behaviors of poor eating habits and physical inactivity, carried from childhood to adulthood [32]. Our study indicated that counties with more obese adults were associated with more obese youth after controlling for socioeconomic factors. It is possible that children and adolescents adopt unhealthy behaviors from their obese parents; however, the genetic factor also needs to be considered since these have not been controlled in the present study. Neighborhood food environment and its impact on childhood obesity also have been examined extensively in the literature [33-36]. Penny et al. suggested that broader community food environment may have a more important influence on adolescent eating habits compared to children. Home/school food environment and parental influence may exert larger impact on younger children [33]. Our findings support the above statements to some extent since school size moderated the food environment index effect on BMI HFZ achievement (figure 3),

considering that most of the schools with an enrollment above one standard deviation beyond the mean were high schools.

College completion is a frequently used proxy measure for socioeconomic status and income inequality is an indicator of resident's wealth disparity. A study examining the interaction of neighborhood economic deprivation and individual parental SES effects on youth obesity also found significant cross-level interaction effects with higher individual-level SES being associated with lower childhood obesity for those who living in high SES neighborhoods, but not for children who lived in low SES areas [37]. Similarly, our study revealed that students attending high SES schools in high SES counties had better results than students attending high SES school in low SES counties. Another significant interaction effects between county and school level correlates was county socioeconomic status and school size. It may provide some insights about different approaches that could be used to intervene in schools with different sizes and from communities with different levels of socioeconomic status. However, due to the lack of literature in this dependent cross-level effects, the results needed to be interpreted cautiously.

A few limitations should be considered when interpreting the results of this study. There is a certain amount of within county variation that has not been explained by school level covariate (enrollment and SES). School health policy and physical education could be possible indicators to explain additional differences we observed between schools, and these should be addressed in other studies. Moreover, the county health indicators studied in the current study were based on the survey data collected from adult or information gathered on adult health status which might not be the most appropriate indicators. It is also possible that other county level indicators not available in the CHR may have stronger impacts on youth health indicators or determinants.

Recommendations in a prominent medical supplement on the global obesity epidemic emphasized that priority should be placed on reversing the nature of the obesogenic environment at the policy level [38]. Thus, it is critical to understand the complex pathways through which macro (e.g., environment and policy) and micro factors (e.g., individual and family) could influence child obesity. The allocation of resources and interventions need to be considered in the less healthy communities and schools to assist them in building healthier environments for youth.

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Table 1. Mean and standard deviation of body mass index in three FITNESSGRAM zones achievements of Texas Youth Fitness Study, United States, 2013-2014

	Girls			Boys		
	N	Mean	SD	N	Mean	SD
Healthy Fitness Zone	14331	56.5	13.7	14571	52.2	13.2
Needs Improvement Some Risk	14331	10.5	5.8	14571	13.9	6.8
Needs Improvement Health Risk	14331	33.0	13.0	14571	33.9	12.3

Note: SD=standard deviation.

Table 2. Mean and standard deviation of school and county level predictors of Texas Youth Fitness Study, United States, 2013-2014

	N	Mean	SD
School Level Predictors			
SES	4922	62.6	25.5
Enrollment	4922	600.0	503.0
County Level Predictors			
Adult Obesity	214	30.1	2.1
Food Environment Index	214	6.5	1.2
Adult Physical Inactivity	214	27.3	2.8
Access to Exercise	214	58.4	23.2
College Completion	214	49.9	9.9
Childhood Poverty	214	27.2	7.9
Income Inequality	214	4.7	0.7

Note: SD=standard deviation.



Table 3. Hierarchical regression analysis in predicting BMI HFZ with school and county health predictors in girls of Texas Youth Fitness Study, United States, 2013-2014

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Fixed effects						
Intercept	56.66** (0.40)	56.25** (0.33)	56.18** (0.33)	56.30** (0.33)	56.17** (0.33)	55.71** (0.37)
Level 1						
SES		7.11** (0.11)	6.91** (0.25)	6.93** (0.25)	6.92** (0.27)	6.62** (0.29)
Enrollment		1.36** (0.12)	1.35** (0.12)	1.50** (0.18)	1.47** (0.19)	0.99** (0.30)
Middle School		-3.05** (0.23)	-3.03** (0.23)	-3.08** (0.23)	-3.07** (0.23)	-3.10** (0.30)
High School		2.68** (0.31)	2.74** (0.31)	2.56** (0.31)	2.60** (0.31)	3.06** (0.37)
Level 2						
Adult Obesity					-0.62* (0.31)	-0.77* (0.34)
Food Environment Index					0.63 (0.42)	0.57 (0.43)
Adult Physical Inactivity					0.37 (0.32)	0.49 (0.32)
Access to Exercise					-0.04 (0.36)	-0.10 (0.37)
College Completion					-0.96* (0.41)	-1.50* (0.53)
Childhood Poverty					1.03* (0.46)	1.37* (0.53)
Income Inequality					-1.64** (0.37)	-1.83** (0.46)
Interaction						
Adult Obesity * SES						0.22 (0.21)
College Completion * SES						0.32 (0.38)
Childhood Poverty * SES						0.20 (0.36)
Income Inequality * SES						0.29 (0.33)
Adult Obesity * Enrollment						0.06 (0.19)
College Completion * Enrollment						-0.83* (0.40)
Childhood Poverty * Enrollment						0.57 (0.34)
Income Inequality * Enrollment						0.02 (0.33)
Adult Obesity * Middle School						0.60** (0.22)
Adult Obesity * High School						0.33 (0.28)
College Completion * Middle School						-0.33 (0.42)
College Completion * High School						0.99 (0.52)
Childhood Poverty * Middle School						-0.06 (0.40)
Childhood Poverty * High School						-0.76 (0.52)
Income Inequality * Middle School						0.33 (0.42)
Income Inequality * High School						0.42 (0.53)
Random Effects						
Level 2						

Intercept/intercept ( $\sigma_{2a0}$ )	25.00** (3.32)	12.92** (1.98)	12.29** (1.96)	11.41** (1.91)	9.49** (1.72)	9.82** (1.78)
SES/ses( $\sigma_{2a1}$ )			2.96** (1.24)	2.98** (1.24)	3.27** (1.37)	1.92 (1.32)
SES/intercept( $\sigma_{2a10}$ )			-1.08 (1.18)	-1.15 (1.12)	-0.04 (1.10)	-0.57 (0.96)
Enrollment/enrollment ( $\sigma_{2a2}$ )				0.61 (0.43)	0.65 (0.46)	0.95 (0.63)
Enrollment/intercept ( $\sigma_{2a20}$ )				-1.03 (0.75)	-0.94 (0.67)	-1.19 (0.76)
Enrollment/ses ( $\sigma_{2a21}$ )				0.49 (0.55)	0.56 (0.60)	0.61 (0.73)
Level 1						
Intercept/intercept (w0)-residual	165.84** (1.97)	120.37** (1.43)	119.37** (1.43)	119.08** (1.43)	118.85** (1.43)	118.82** (1.43)
AIC	114269.1	109617.7	109576.4	109571.4	109310.7	109293.8

Note: \* $p < 0.05$ , \*\*  $p < 0.01$ , SES = socioeconomic status.

Table 4. Hierarchical regression analysis in predicting BMI HFZ with school and county health predictors in boys of Texas Youth Fitness Study, United States, 2013-2014

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Fixed effects						
Intercept	52.37**(0.38)	52.09** (0.34)	52.04** (0.34)	52.10** (0.33)	51.93** (0.33)	51.88** 0.36)
Level 1						
SES		6.17** (0.11)	4.86** (0.32)	4.94** (0.32)	4.82** (0.33)	4.61** (0.34)
Enrollment		0.81** (0.12)	0.68** (0.12)	0.68** (0.18)	0.60** (0.20)	0.36 (0.25)
Middle School		-1.58** (0.23)	-1.47** (0.23)	-1.52** (0.23)	-1.49** (0.23)	-1.38** (0.31)
High School		0.28 (0.30)	0.72* (0.30)	0.60* (0.31)	0.64* (0.31)	0.11 (0.36)
Level 2						
Adult Obesity					-0.28 (0.30)	-0.26 (0.30)
Food Environment Index					1.21** (0.43)	1.27* (0.50)
Adult Physical Inactivity					0.37 (0.31)	0.41 (0.31)
Access to Exercise					0.16 (0.37)	-0.007 (0.37)
College Completion					-1.34** (0.42)	-0.91* (0.46)
Childhood Poverty					0.30 (0.46)	0.08 (0.46)
Income Inequality					-1.39** (0.37)	-2.12** (0.44)
Interaction						
Food Environment Index* SES						-0.47 (0.40)
College Completion * SES						0.94** (0.31)
Income Inequality * SES						0.38 (0.37)
Food Environment Index * Enrollment						0.69* (0.27)
College Completion * Enrollment						0.02 (0.21)
Income Inequality * Enrollment						-0.38 (0.25)
Food Environment Index * Middle School						-0.35 (0.41)
Food Environment Index * High School						0.79 (0.49)
College Completion * Middle School						0.08 (0.28)
College Completion * High School						-1.11** (0.35)
Income Inequality * Middle School						0.42 (0.38)
Income Inequality *High School						1.73** (0.46)
Random Effects						
Level 2						
Intercept/Intercept ( $\sigma^2_{a0}$ )	23.65** (3.09)	13.81** (2.08)	13.04** (2.07)	11.59** (1.89)	9.14** (1.65)	9.30** (1.63)
SES/SES( $\sigma^2_{a1}$ )			7.48** (2.08)	7.33** (2.03)	7.47** (2.03)	5.54** (1.78)
SES/Intercept( $\sigma^2_{a10}$ )			-1.86 (1.48)	-1.71 (1.37)	-0.12 (1.40)	-0.18 (1.22)
Enrollment/Enrollment ( $\sigma^2_{a2}$ )				0.96* (0.56)	1.05* (0.59)	0.59* (0.34)

Enrollment/Intercept ( $\sigma_{2a20}$ )				-2.06** (0.69)	-1.94** (0.68)	-1.92** (0.59)
Enrollment/SES ( $\sigma_{2a21}$ )				1.22 (1.00)	1.07 (1.02)	0.37 (0.83)
Level 1						
Intercept/intercept (w0)-residual	153.36** (1.81)	125.08** (1.48)	123.17** (1.46)	122.73** (1.46)	122.50** (1.46)	122.35** (1.46)
AIC	115051.5	112010.3	111920.4	111900.0	111571.3	111515.6

Note: \* $p < 0.05$ , \*\*  $p < 0.01$ , SES = socioeconomic status.

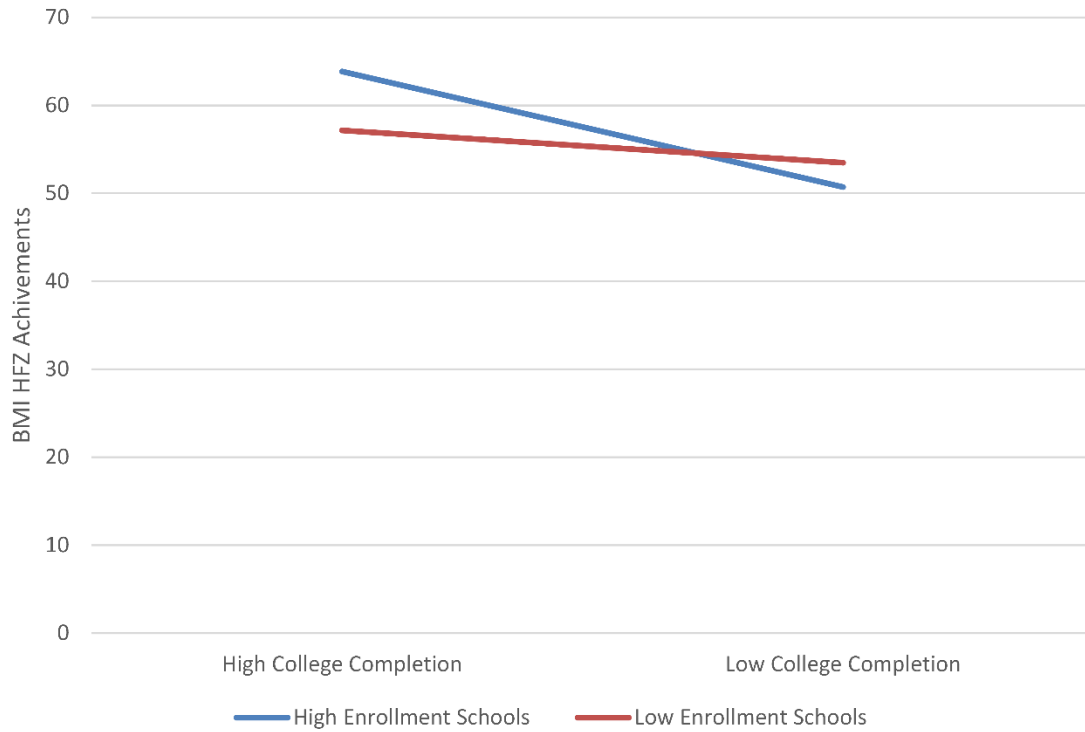
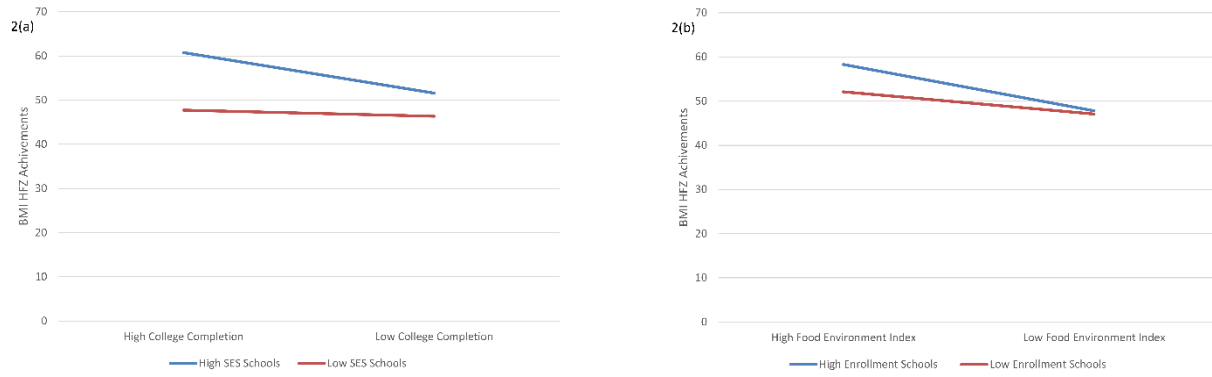


Figure 1. The cross-level interaction effects of school and county level predictors on girls BMI HFZ achievements of Texas Youth Fitness Study, United States, 2013-2014

Note: BMI = body mass index.



**Figure 2.** The cross-level interaction effects of school and county level predictors on boys BMI HFZ achievements of Texas Youth Fitness Study, United States, 2013-2014

Note: SES = socioeconomic status.

## **CHAPTER 4. LONGITUDINAL CHANGES IN YOUTH BODY MASS INDEX IN THE STATE OF TEXAS FROM 2011 TO 2014**

### **Abstract**

**BACKGROUND:** The state of Texas passed the legislation Bill 530 requires that all public schools conduct annual physical fitness testing with FITNESSGRAM but studies to date have not examined trends in Body Mass Index (BMI) data collected under the mandate statewide testing.

**PURPOSE:** The purpose of the study was to evaluate longitudinal trends in youth BMI normal weight and obese prevalence in Texas and determine if school characteristics were associated with disparities in obese prevalence.

**METHODS:** BMI data were collected by trained teachers across the state and the FITNESSGRAM health-related standards were used to evaluate students' BMI into either Healthy Fitness Zone (HFZ), Needs Improvement Zone (NIZ), and Needs Improvement Health Risk (NIHR) zones. Four years of grade and gender specific group level HFZ, NIZ, and NIHR for each school was provided by Texas Education Agency. Schools submitted at least 3 years data remained in the final sample. Growth curve models were applied to estimate the change in HFZ and NIHR separately for three school levels and genders, after controlling for school enrollment and socioeconomic status (SES).

**RESULTS:** A range of 4,655 to 5,075 schools were included in the final samples from 2011 to 2014 with approximately 2-3 million students in each sample year. The HFZ prevalence ranged from 55% to 63% for girls and 50% to 55% for boys. Small but significant increases in HFZ were found in most age and gender comparison groups. Improvements in the prevalence of HFZ were evident among elementary and middle school girls and boys with annual increases in

achievement rates ranging from 0.21% to 0.85%. A quadratic trend was found in high school girls with a change of 1.08%, 0.52%, and -0.04%. Similar linear trends with a range of 0.22% to 0.35% annual decrease were discovered in NIHR across gender and school levels except for high school girls. Higher proportion of students qualified for free and reduced lunch and smaller school enrollment was associated with worse children and adolescents weight profile.

**CONCLUSIONS:** There was a higher percentage of students in the normal weight category over four years in Texas public school systems except for high school boys. Lower obesity prevalence was found in all age groups and genders. Clear weight status disparities were observed in schools with different SES and enrollment.



## **Introduction**

The prevalence of obesity among U.S. children and adolescents has remained stable over the past decade but it is still very high according to national representative data from the National Health and Nutrition Examination Survey [1]. Attention has recently focused on the disparities in childhood obesity across different ethnic and socioeconomic groups[2]. Special interest have placed on obesity surveillance in small areas such as at state [3, 4], county [5], city [6], and community level [7]. The value of more localized analyses is that it allows policy-makers and local public health leaders to better evaluate patterns and to focus attention and resources on areas with the greatest need [8, 9].

Available data from school-based fitness evaluations provides a promising data source to examine factors influencing fitness patterns and profiles in youth. The FITNESSGRAM program is the most widely used assessment program and a number of states have mandated assessments in schools to facilitate effective school based surveillance systems [10]. In 2007, Texas registration passed Senate Bill 530 as a state mandate to increase PA and fitness in public schools [11, 12]. FITNESSGRAM was been selected as the mandated fitness testing battery and schools have been submitting the data to the state on an annual basis to facilitate surveillance. A research project funded by the Robert Wood Johnston Foundation was launched in 2009 to systematically evaluate the data collected in Texas during the first year of the mandate and findings were summarized through a series of studies in a journal supplement [12]. One study demonstrated that trained teachers can collect reliable and valid fitness data [13]. A paper by Welk et al [14] summarized the descriptive patterns of fitness and fatness across the state as well as the geo-spatial variability by county. Other accomplishments included demonstrating that

healthier students were associated with superior academic achievement[15] and determining the significant teacher/school characteristics that predict youth fitness [16].

The Texas Youth Fitness Project provided valuable insights about youth fitness but findings were solely based on cross sectional data. The dataset becomes more valuable when examined over time but no studies, to date, have evaluated the longitudinal data to examine the secular trends of Texas youth obesity and overweight. Thus, the purpose of this present study is to evaluate the statewide longitudinal changes (from 2011 to 2014) in BMI profiles from more than 3 million Texas youth fitness data collected each year through the state mandated collection of FITNESSGRAM data. The second purpose is to determine the school characteristics that may explain disparities in youth BMI profiles across the state.

## **Methods**

### *Study Population*

Data were obtained from the Texas Education Agency (TEA), the agency who manages the Texas statewide health-related physical fitness testing in the state. The TEA provided resources needed to conduct the fitness testing and training for all the public school teachers on the FITNESSGRAM test protocols. PE teachers are responsible to have students practice the tests, obtain the measures, and report the test results to TEA. Youth fitness data have been submitted to TEA and aggregated by grade and gender with FITNESSGRAM standards by TEA since 2007. Because the health-related standards built in the FITNESSGRAM were modified in 2011[17], only 4 years data from 2011 to 2014 were included in the current study. The present study also examined only the BMI data since the focus was on examining factors that may influence obesity patterns and trends. The BMI health-related standards in FITNESSGRAM were established based on risks for metabolic syndrome in children and adolescents [18, 19]. The

values were extrapolated onto standard CDC growth charts to take into account normal growth and maturation but differ slightly from the cutoffs for overweight and obesity. The FITNESSGRAM thresholds for the Needs Improvement Zone (NIZ) and the Needs Improvement Health Risk (NIHR) correspond to the 83rd and 92nd percentiles in boys and the 80th and 90<sup>th</sup> percentiles in girls.

### *Assessment*

Height was measured by students standing straight without shoes, heavy clothes, hats, and barrettes. Students were asked to stand with back and feet against the wall on a flat surface. Body Mass Index was calculated as  $(\text{weight in kg})/[(\text{height in m})^2]$ . BMI data was reported by school teachers and percentage of students were HFZ, NIZ and NIHR as well as the total number of students were measured in BMI were computed by TEA. TEA also provided school level demographic characteristics about enrollment, minority distribution, and economic disadvantage. Economic disadvantage, which is students qualified for free and reduced lunch program, was used as the proxy of school socioeconomic status (SES) indicator.

### *Statistical analysis*

The TEA started to promote the use of FITNESSGRAM web-based software in fall 2013 to allow individual data to be directly submitted. About one third of the schools adopted the web-based software in 2014 academic year. The individual data was evaluated with the same thresholds used in the 2011-2013 academic years to classify each student's BMI as HFZ, NI and NIHR. The grade and gender specific HFZ, NI and NIHR percentage were calculated for each school and merged with the rest of two thirds schools in 2014. The four years age- and gender-specific aggregated BMI data from 3<sup>rd</sup> to 12<sup>th</sup> grade Texas public school students were merged by unique school id, gender, and grade. Data were excluded if the submitted total number of

students was less than 10 within each grade and gender group per school. Data were also excluded if less than 3 years data were submitted by any grade and gender within each school. Grade 3<sup>rd</sup> to 5<sup>th</sup> were coded as elementary schools, grade 6<sup>th</sup> to 8<sup>th</sup> were coded as middle schools, and grade 9<sup>th</sup> and above were high schools. Preliminary evaluation was taken to examine the distribution of school demographic characteristics, which remained relatively consistent in the past four years. Therefore, the school characteristics data were treated as invariant variables in the statistical model and the most recent 2014-2015 data was used. Due to the high correlation of minority proportion and SES, to avoid the collinearity, only SES and enrollment were included in the models as school characteristic predictors. Both SES and enrollment data were standardized before entering into the statistical models to facilitate the interpretation.

Descriptive statistics of school level specific HFZ, NIZ and NIHR by year were computed for boys and girls. Growth curve analysis were used to model the trajectories of youth HFZ and NIHR prevalence in between 2011 to 2014 after controlling for school enrollment and SES. A series of hierarchical models were fitted to estimate the rate of changes over time (slope) and the baseline youth fitness in 2010-2011 academic year (intercept). Model 1 is an unconditional means model, which is the simplest random intercept linear model to estimate how much grades vary in their mean percent HFZ using within-subject correlation. Model 2 is a random slope models to estimate how time (i.e., year) variable predicted the variation of HFZ within-grade level. In model 3, quadratic and cubic terms of year were included in extensions to the random slope model, but these terms were excluded from the model if there was a lack of statistical significance. In model 4, individual school predictor SES and enrollment were introduced as fixed effects level 2 variables to explore how school SES and enrollment predicted the variation of HFZ at between-grade level. Cross-level interaction effect of time and school

characteristics variables that were significant in Model 4 were added in the Model 5. Considering the large data set, fully multivariate model was used to fit the model without restrictions on the covariate matrix. Model with the smallest Akaike information criterion (AIC) was selected as the final model to report the results. The similar model specification and selection procedure was repeated for outcome NIHR. The growth curve analysis were tested among girls and boys in three school levels, respectively. All statistical analyses were conducted with SAS version 9.4 (SAS Institute Inc, Cary, North Carolina).

## Results

The numbers of schools retained in the final sample slightly varied across the 4 years because schools submitted three years data were allowed to be included. Thus, the final sample included 5,075 schools with 2,162,356 students in 2011, 4,989 schools of 1,802,319 students in 2013, 4,977 schools of 3,237,080 students in 2014, and 4,655 schools of 2,617,859 students in 2015. The average enrollment was 624 with a standard deviation of 509 and approximately 62.1% students (standard deviation=25.8%) were eligible for free and reduced lunch based on the school data from 2011. The descriptive results of HFZ, NIZ, and NIHR prevalence were reported in Table 1 stratified by gender, school level, and year. The prevalence of HFZ increased in both girls and boys across school levels, but the change was modest with an approximate range of 0.5% to 2% over 4 years, except for high school boys. The prevalence of NIZ and NIHR decreased proportionally in most age groups to compensate for the increase in HFZ percentage. The exception was among high school girls where the increase in HFZ achievements complemented the decrease in NIHR rates with NIZ remaining the same percentages. For the age group comparison, the HFZ achievements was around 50% in elementary and middle age groups

and 55% among high school boys. Girls had higher HFZ of 55% in younger groups and approximately 63% among high schoolers.

#### Longitudinal changes in HFZ achievements

Table 2 demonstrates gender-specific estimates of the HFZ at baseline and the change over time after controlling for school enrollment and SES. We found that there was a linear increase in achievement rates for both elementary girls (0.39% per year, SE=0.05,  $P<0.01$ ) and middle school girls (0.27% per year, SE=0.07,  $P<0.01$ ). A significant quadratic term for Year was found in the model for high school girls, thus the annual changes were 1.08%, 0.52%, and -0.04% for the last three years when treating the 2011 as the baseline data. For boys, a significant linear change was found in elementary schools with an annual increase of 0.51% (SE=0.05,  $p<0.01$ ). Significant quadratic trends were found in adolescent boys with change of 0.21%, 0.53%, and 0.85% among middle schoolers and -0.71%, 0.13%, and 0.85% among high schoolers over the last 3 years.

#### Impact of SES and Enrollment on baseline and change in BMI HFZ achievements

Both SES and enrollment were significant predictors in estimating the baseline HFZ in girls across different school levels. A 1 SD unit increase in students qualified for free and reduced lunch was associated with 6.79%, 7.32%, and 6.90% lower baseline HFZ in elementary, middle, and high school girls. Additionally, a 1 SD unit increase in school enrollment was associated with 1.97%, 2.11%, and 1.72% higher baseline HFZ in elementary, middle, and high school girls. Similar to girls, the SES was associated with higher baseline HFZ among boys. A 1 SD unit increase in students eligible for free and reduced lunch was associated with 7.00%, 6.47%, and 4.60% lower percentages of boys who were classified in baseline HFZ among elementary, middle, and high schools, respectively. An increase of 1 SD unit in school

enrollment was associated with 0.97% and 1.39% increase in baseline HFZ among middle and high school boys but enrollment was not a significant predictors in baseline HFZ among elementary school boys.

A significant cross-level interaction term was found in Year\*SES among high school girls, indicating that a 1 SD unit increase in SES was associated with 0.34% lower annual change in HFZ. The impact of SES was not significant in boys however there enrollment moderated the changes over time in boys.

#### Longitudinal changes in NIHR

The growth curve analysis results of NIHR were summarized in Table 3. Significant lower obesity prevalence was found in girls across three school levels. Significant linear trends were found in elementary and middle school girls with a 0.25% and 0.22% annual decrease in NIHR. Significant quadratic trends were found among high school girls with 1.12%, 0.52%, and -0.08% decreases over the last 3 years. For boys, the changes of NIHR were similar in elementary, middle, and high schools with a linear decrease of 0.35% (SE=0.05,  $p<0.01$ ), 0.24% (SE=0.07,  $p<0.01$ ), and 0.24% (SE=0.08,  $p<0.01$ ), respectively.

#### Impact of SES and Enrollment on baseline and change in BMI NIHR achievements

Both school SES and enrollment were significant predictors in estimating baseline NIHR among girls. A 1 SD unit increase of students qualifying for free and reduced lunch was associated with 6.56%, 6.68%, and 6.41% lower baseline NIHR in elementary, middle, and high school girls. School enrollment was only associated with baseline NIHR among high school girls ( $\beta=-1.41$ , SE=0.07,  $p<0.01$ ). Similar to girls, 1 SD unit increase in SES was associated with 6.79%, 6.07%, and 4.36% increase in baseline NIHR among elementary, middle and high school boys, respectively. Higher school enrollment was associated with lower NIHR in middle and

high school boys. There were no statistically significant moderators of the changes in the proportion of students in the NIHR zone.

## **Discussion**

The present study revealed the longitudinal changes in BMI distributions in Texas children and adolescents based on the annual data submitted through the mandated FITNESSGRAM assessments. Small but positive weight distribution shifts from NI or NIHR to HFZ has been observed in most of the age groups in boys and girls, except for high school boys. It is not possible to quantify the specific changes at the individual level due the aggregated nature of the data; however, the shifts are clearly indicative of improved BMI distributions. Considering the large number of participants in the study, thousands of youth in Texas have improved their weight status from 2011 to 2014, which indicates the substantial public health impact.

It is encouraging that all but high school boys showed positive increase in HFZ achievements over these 3 years (the 2011 data were treated as the baseline). The unique nature of the sample makes comparison difficult but one possible comparison can be made with annual data from the Youth Risk Behavior Surveillance System (YRBSS), a state-surveillance tool that tracks health risk behaviors in each state using representative samples of 9<sup>th</sup> through 12<sup>th</sup> graders. As the YRBSS collects data every two years, the comparable years to our study were 2011 and 2013. A relatively stable obesity and overweight prevalence pattern was reported from representative samples of 3,980 and 3,039 Texas adolescents in these two years according to YRBSS. The obesity prevalence was 15.6% and 15.7% in 2011 and 2013 while the overweight prevalence decreased from 16.0% to 15.6% at the same time frame among Texas high schoolers. Because the YRBSS didn't report the gender specific results, no further comparisons can be



made for boys and girls separately but both data sources are consistent in the reporting of slight declines in obesity prevalence in high school youth.

Similar patterns of children and adolescents weight profile improvement were also noted in other states mandating statewide fitness testing. The Georgia Student Health and Physical Education (S.H.A.P.E.) Act requires local school district to conduct annual fitness assessment since 2011. In a separate study analyzing 3 years of student BMI data from Georgia revealed approximately 1% to 2 % annual increases in HFZ achievements among elementary school girls and boys and 0.5% increase per year among middle school boys. California has also tracked FITNESSGRAM fitness results in 5<sup>th</sup>, 7<sup>th</sup>, and 9<sup>th</sup> grade since 2001. The California Department of Education compile the test results and post the aggregated data on their website each year. The data from comparable three years 2011-2013 showed steady increases in HFZ achievements among California elementary school students, and middle school girls. Specifically, the HFZ achievements in elementary girls were 55.7%, 56.0%, and 56.7% from 2011 to 2013, and 48.7%, 49.2%, 49.9% among elementary boys. The middle school boys increased from 53.6% in 2011, 53.8% in 2012, to 54.8% in 2013. Middle school girls and high school boys remained similar HFZ achievements in a range of 57.1% to 57.4% and 57.1% to 57.5%, respectively. Slightly more high school girls were classified in NIHR over the three years. An earlier research study examined the California statewide youth BMI surveillance data from 2001 to 2008 and revealed that prevalence of high BMI in all age and ethnicity groups had declined except for American Indian and black girls [20].

Similar trends were found in younger groups with a positive change in the past three or four years among all three states. Because the mandated testing captures millions of students in each state, the similar secular change patterns from three separate states are noteworthy. One

possible reason to explain the improvement in children's weight status could be the efficacy of state supported health eating and physical activity programs. In Texas, all school districts are required by law to implement a coordinated school health program in grades K-8 and TEA provides one or more coordinated health programs available to each school district. It is also required by law for each school district to have a School District Health Advisory Council formed with a group of individuals representing segments of the community to provide advice on coordinated school health programming. The Georgia S.H.A.P.E. Act promotes Power Up for 30, a program provides 30 minutes of physical activity through before/after school, classroom, recess, physical education, staff wellness, Family/community engagement, special event, primarily in elementary schools. California has the Team California for Healthy Kids Campaign to promote healthy eating and physical activity through Active Schools, Active Families, and Active Communities. In addition, Texas Senate Bill 530 improved the school-based PA requirement that K-5 students should have at least 30 min/day five times per week PE or 45 min/day three times per week, or 225 min/week under block schedule at school setting. Grade 6<sup>th</sup> to 8<sup>th</sup> students should complete 4 out of 6 semesters PE with the same amount of weekly duration as does the requirement in elementary schools [12]. The revised PE requirement by the legislation in Texas could also contribute to the improvement in youth weight status.

The overall percentage of students classified in HFZ were still relatively low indicating large room for improvement among Texas children and adolescents. Compared to the NHANES BMI surveillance data, approximately 10% -12% fewer boys and 9% fewer elementary girls were in the HFZ in Texas compared to the national average. Several explanations can contribute to the disparities existing between Texas and the national average. The most direct explanation is that the FITNESSGRAM criterion-referenced BMI standards differ slightly from the standard

CDC BMI growth chart cutoffs for overweight and obesity [19, 18]. The FITNESSGRAM values are slightly lower than the CDC 85<sup>th</sup> and 95<sup>th</sup> BMI percentiles so approximately 2% to 5% discrepancies are likely due to the evaluation standards (i.e. 2-5% of students would not be classified in NI if CDC standards were used). It is worth pointing out that the current FITNESSGRAM version 10 have adopted the CDC standards because the CDC thresholds are more widely used in clinical settings and because they have both been shown to have similar utility for detecting metabolic syndrome [21]. However, the aggregated nature of the samples available from the TEA prevent a more detailed evaluation based on the CDC BMI standards. In addition to the differences in standards, it is possible that Texas youth simply have worse youth weight profile compared to national average. The YRBSS sampled high school youth from the most recent two cycles of data showed that Texas youth had 2.6% and 2% higher obesity prevalence than national average in 2011 and 2013, respectively. Additionally, the self-reported adult obesity prevalence was 31.9% in Texas ranked 11<sup>th</sup> among the fifty states according to the 2014 Behavioral Risk Factor Surveillance System results. As both Texas adolescents and adults obesity prevalence are above national average, it is likely that the differences reflect actual higher obesity and overweight prevalence in Texas children and adolescents.

Consistent with expectations, SES was a strong predictor in explaining the baseline weight status variation in current study. Moreover, the strength of the association of SES and HFZ and NIHR prevalence were similar across gender and school level. Bai et al. identified SES as the strongest school level demographic indicator in predicting the youth fitness disparities in an evaluation of data from hundreds of schools in the NFL PLAY 60 FITNESSGRAM Partnership Project (under review). A recent study might provide insights about the rationale of low SES school is associated with more obese students. Carlson et al. found that there was a lack

of PE teacher in low SES elementary schools and fewer physical activity-supportive physical education practices than did high SES schools, which resulted in students attending low SES schools participated less moderate-and-vigorous PA in school setting [22]. Moreover, school enrollment showed significant predictive characteristic in explaining the variance in youth BMI in the present study. The underlying justification was not clear but one possible explanation could be that the larger schools usually equipped with more resources and trained PE teachers. Further research needs to explore this inconclusive explanation.

The positive weight status shifts observed in Texas children and adolescents are encouraging but additional surveillance studies are needed to confirm the trajectories. Further studies are also needed to explore the longitudinal BMI trends in other ethnic groups among Texas youth and the factors that may explain the improvements. The recent adoption of FITNESSGRAM version 10 allows the submission of individual student record in Texas youth fitness surveillance system which also provides opportunities to examine and monitor the individual BMI longitudinal trends, especially in the high obesity prevalence sub populations.

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Table 1. Descriptive results of normal weight, overweight, obese prevalence by gender, school level, and year.

Year	Boys						Girls					
	Elementary		Middle		High		Elementary		Middle		High	
	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)
Healthy Fitness Zone												
2012	8305	50.2 (13.3)	3443	50.0 (11.1)	3023	55.2 (10.9)	8264	54.4 (12.9)	3468	53.5 (11.6)	2804	61.4 (12.0)
2013	8205	50.3 (13.3)	3367	50.1 (11.6)	2917	54.8 (12.7)	8188	54.5 (13.0)	3384	54.1 (12.1)	2718	63.3 (13.5)
2014	7960	51.4 (13.5)	3240	50.9 (11.8)	2804	54.4 (12.9)	7940	55.2 (13.2)	3230	54.4 (12.4)	2593	62.7 (14.0)
2015	7046	51.5 (13.4)	2915	51.5 (11.8)	2521	55.5 (13.3)	7028	55.4 (13.2)	2943	54.3 (12.4)	2341	63.5 (14.3)
Needs Improvement Some Risk Zone												
2012	8305	13.1 (5.8)	3443	16.3 (5.8)	3023	15.1 (6.2)	8264	9.8 (5.2)	3468	12.4 (4.9)	2804	11.9 (5.2)
2013	8205	13.1 (5.8)	3367	16.1 (5.8)	2917	15.8 (7.4)	8188	9.7 (5.1)	3384	12.3 (5.0)	2718	11.7 (6.1)
2014	7960	13.1 (6.0)	3240	16.1 (6.0)	2804	16.2 (7.9)	7940	9.7 (5.2)	3230	12.2 (5.5)	2593	11.9 (6.3)
2015	7046	12.6 (5.9)	2915	15.3 (5.9)	2521	15.6 (8.0)	7028	9.3 (5.1)	2943	12.2 (5.4)	2341	11.6 (6.3)
Needs Improvement Health Risk Zone												
2012	8305	36.7 (12.5)	3443	33.7 (10.5)	3023	29.7 (9.6)	8264	35.8 (12.1)	3468	34.1 (10.8)	2804	26.7 (10.7)
2013	8205	36.6 (12.5)	3367	33.8 (10.7)	2917	29.3 (11.2)	8188	35.8 (12.2)	3384	33.6 (11.2)	2718	25.0 (11.8)
2014	7960	35.6 (12.4)	3240	33.0 (10.7)	2804	29.4 (11.8)	7940	35.2 (12.4)	3230	33.3 (11.6)	2593	25.4 (12.5)
2015	7046	36.0 (12.5)	2915	33.2 (10.8)	2521	28.9 (11.6)	7028	35.3 (12.4)	2943	33.5 (11.3)	2341	24.9 (12.9)

Note. SD=standard deviation.

Table 2. Growth curve regression analysis results of longitudinal trends in Healthy Fitness Zone achievements by school levels in girls and boys.

	Girls			Boys		
	Elementary	Middle	High	Elementary	Middle	High
Fixed Effects						
Intercept	55.98 (0.14)**	53.14 (0.14)**	57.37 (0.23)**	51.01 (0.15)**	49.53 (0.16)**	52.34 (0.21)**
SES	-6.79 (0.08)**	-7.32 (0.12)**	-6.90 (0.20)**	-7.00 (0.08)**	-6.47 (0.12)**	-4.60 (0.16)**
Enrollment	1.97 (0.28)**	2.11 (0.17)**	1.72 (0.10)**	-0.28 (0.30)	0.97 (0.17)**	1.39 (0.08)**
Rate of Change						
Year	0.39 (0.05)**	0.27 (0.07)**	1.36 (0.31)**	0.51 (0.05)**	0.05 (0.23)	-1.10 (0.30)**
Year*Year			-0.28 (0.10)**		0.16 (0.08)*	0.39 (0.10)**
SES*Year			-0.34 (0.10)**			
Enrollment*Year			-0.07 (0.05)			
Random Effects						
Intercept	85.29 (0.99)**	73.56 (1.34)**	96.34 (1.57)**	84.12 (0.97)**	71.21 (1.31)**	101.84 (2.00)**
Level-one variance	35.37 (1.67)**	20.31 (2.03)**	17.42 (2.31)**	44.36 (1.78)**	25.32 (2.10)**	13.19 (2.69)**
Level-two variance	2.23 (0.39)**	0.70 (0.50)	.	2.45 (0.39)**	1.80 (0.52)**	1.11 (0.76)

Note. SES=socioeconomic status.

\* denotes  $p < .05$ ; \*\* denotes  $p < .01$ .



Table 3. Growth curve regression analysis results of longitudinal trends in Needs Improvement Healthy Risk zone by school levels in girls and boys.

	Girls			Boys		
	Elementary	Middle	High	Elementary	Middle	High
	Fixed Effects					
Intercept	34.21 (0.13)**	34.45 (0.14)**	30.33 (0.20)**	35.68 (0.14)**	34.21 (0.14)**	32.35 (0.17)**
SES	6.56 (0.07)**	6.68 (0.11)**	6.41 (0.15)**	6.79 (0.07)**	6.07 (0.11)**	4.36 (0.14)**
Enrollment	-2.03 (0.25)	-1.93 (0.16)	-1.41 (0.07)**	-0.02 (0.26)	-1.04 (0.16)**	-1.19 (0.07)**
Rate of Change						
Year	-0.25 (0.05)**	-0.22 (0.06)**	-1.42 (0.27)**	-0.35 (0.05)**	-0.24 (0.07)**	-0.24 (0.08)**
Year*Year			0.30 (0.09)**			
SES*Year						
Enrollment*Year						
	Random Effects					
Intercept	77.30 (0.89)**	62.65 (1.14)**	76.54 (1.56)**	74.53 (0.86)**	59.50 (1.09)**	81.62 (1.29)**
Level-one variance	26.42 (1.43)**	18.71 (1.76)**	14.15 (2.20)**	34.11 (1.50)**	24.04 (1.83)**	8.64 (1.76)**
Level-two variance	1.90 (0.35)**	0.63 (0.43)	0.45 (0.58)	1.88 (0.34)**	1.71 (0.44)**	

Note. SES=socioeconomic status.

\* denotes  $p < .05$ ; \*\* denotes  $p < .01$ .

## CHAPTER 5. THE LONGITUDINAL IMPACT OF NFL PLAY 60 PROGRAMMING ON YOUTH AEROBIC CAPACITY AND BODY MASS INDEX—RESULTS FROM THE NFL PLAY 60 FITNESSGRAM PARTNERSHIP PROJECT

### Abstract

**BACKGROUND:** Fuel Up to PLAY 60 and PLAY 60 Challenge are the most widely adopted physical activity and healthy eating promotion programs in the NFL PLAY 60 campaign. However, little is known about the effectiveness of these programs in promoting youth fitness in school settings.

**PURPOSE:** The purpose of the study was to evaluate the impact of NFL PLAY 60 programming on longitudinal trajectories of youth aerobic capacity and Body Mass Index (BMI).

**METHODS:** Data were from the NFL PLAY 60 FITNESSGRAM Partnership Project, a large participatory research project. A total of 497 schools completed assessments of aerobic capacity and BMI annually starting in 2011 and annually through 2015 and these data were processed using established FITNESSGRAM standards to calculate the percentage of students meeting the Healthy Fitness Zone (HFZ) for each test. Adoption of NFL PLAY 60 programming was encouraged but not required. Growth curve modeling was used to estimate the change in the longitudinal trajectories of aerobic capacity and BMI HFZ achievement for schools that did or did not participate in NFL PLAY 60 programming stratified by gender. The impact of length of program participation on longitudinal trajectories was also examined.

**RESULTS:** Approximately 19% of schools met the criteria of being an NFL PLAY 60 programming school. Annual improvements in aerobic capacity as reflected by achievement of the HFZ were significantly greater in schools that participating in the programs for both girls (3.03%,  $P < 0.01$ ) and boys (2.87%,  $P < 0.01$ ) than non-programming schools. Smaller differences

in trajectories of BMI HFZ achievement were evident in girls from schools that participated in the programs (1.27%,  $P<0.05$ ) and in boys (1.19%,  $P<0.05$ ) when compared to non-participating schools. Analyses revealed that schools which implemented the programs for the entire 4 year period tended to have better improvements in aerobic capacity than schools which enrolled for only 2 or 3 years.

**CONCLUSIONS:** The results of these longitudinal analyses support the utility of the NFL PLAY 60 physical activity promotion programs for improving youth aerobic capacity and reversing the prevalence of overweight/obesity.

## Introduction

The high prevalence of obesity in U.S. children remains a significant public health problem and there are now similar concerns about low levels of physical activity (PA) in youth. The most recent National Youth Fitness Survey revealed that more than 34% 6-19 years old youth are overweight or obese [1] and only 42.2% of 12-15 years youth have adequate levels of cardiorespiratory fitness, a 10% decrease over the past 10 years [2]. Numerous studies have documented the effects of various school-based PA intervention, including a number of randomized control trials [3]. The magnitude of intervention effects have varied by study design, targeted population, duration of the intervention, and means of delivering programming[4, 5]. Recent review studies indicate that interventions utilizing comprehensive school-based models, environmental changes, and multicomponent programs were more effective than other interventions [6, 5]. In addition, interventions coordinating efforts from multiple organizations in the community beyond the school setting have demonstrated greater capacity to increase PA [7]. Despite this evidence of effectiveness it has proven difficult to systematically disseminate these programs on a large scale [8].

A number of national initiatives such as Lets Move! and the NFL PLAY60 program seem to overcome the limitations of conventional interventions [9, 10]. These campaigns represent large-scale and high-visibility programming and often use multicomponent, multisector, and multisite strategies. They utilize more realistic approaches designed with schools and teachers in mind and promote adoption through grant applications, direct advertising, and mass media campaigns to raise public awareness. A key distinction in these programs is that schools choose to take action and programming is typically led by local leaders or community members who know how to create change in their local settings. These initiatives provide assistance and

resources to support the development and implementation of the health enhanced programs but few studies have evaluated the impact of these programs in a systematic way. Quantifying the efficacy of these new participatory models in communities is an important public health research priority since these programs offer more opportunities to impact population health than traditional school-based intervention trials which rarely move into a dissemination phase. Studies evaluating programming under real-world conditions is critical for obtaining practice-based evidence and for examining external validity [11].

The present study addresses this gap by systematically evaluating the impact of the NFL PLAY 60 programs through a large participatory research network of over 1000 schools. Because the NFL PLAY 60 programs focus on school-based PA and fitness promotion, the focus of the analyses is on evaluating the impact on school-level changes in aerobic capacity (AC) and body mass index (BMI) over time.

## **Method**

### **Study Design**

The data from this study came from a large participatory research network called the NFL PLAY 60 FITNESSGRAM Participatory Project. The project, funded by the NFL foundation and administered by the Cooper Institute, was designed to test NFL PLAY 60 programming in samples of schools from each of the 32 NFL franchise cities. Each franchise was offered 35 site licenses including free FITNESSGRAM software, training, and technical support. Schools were encouraged to fully utilize the FITNESSGRAM program and to consider implementing some of the various NFL PLAY 60 programs to enhance their school wellness programming. The two most prominent programs targeted were the PLAY 60 Challenge operated by the American Heart Association and Fuel Up to PLAY 60 developed by National Dairy Council. Schools were asked

to assess their student's fitness each year and to enter the data through the web-based FITNESSGRAM system. They were also asked to complete a baseline and annual surveys which collected information about their PE programs, school health policy, fitness testing administration, and implementation of PA and nutrition programs. Due to the participatory nature of the project schools had autonomy to run programs in their own way. The engagement and involvement of schools was systematically tracked and schools were dropped and added in a dynamic manner to establish a cohort of committed schools. The details about the project and the design of the evaluation are summarized in a separate paper (Welk et al., In Press).

#### Dependent Variables

Individual BMI and AC were measured by trained PE teachers, which was required each semester by the project. BMI was calculated as  $\text{weight (kg)} / [\text{height (m)}]^2$ . AC was measured by either PACER (Progressive Aerobic Cardiovascular Endurance Run) or the one-mile run test; the PE teacher decided which test to use. Either PACER laps or one mile run minutes were entered into the FITNESSGRAM web-based software [12]. Student achievement on the AC and BMI assessments were evaluated with the established health-related FITNESSGRAM criterion standards to determine whether each individual student was in the Healthy Fitness Zone (HFZ) or not [13]. The grade-level HFZ achievement was calculated separately within each gender [14]. The percentages of HFZ achievement in the same grade from multiple years were modeled (e.g., HFZ achievement from different cohorts of 4th grade boys were then compared from 2012 to 2015). Spring data were used as the primary fitness measure if schools submitted both fall and spring data.

Because of the unique design of the study there were new schools enrolled in the project each year. To evaluate program effectiveness school-specific project years were used to

represent change on the outcome variables. For example, the first year the school enrolled in the project and submitted fitness data was labeled as Year 1 regardless of which calendar year the school enrolled. As a result, some schools provided up to 4 years of fitness data but others provided only one year of fitness data. To evaluate change in fitness only schools that submitted at least two years of data between the Fall of 2011 and Spring 2015 (Wave 1 to Wave 4) were included in the analyses.

### Programs

Fuel Up to Play 60 was launched by the National Dairy Council and the NFL in collaboration with the United States Department of Agriculture (USDA). The program was designed to encourage youth to adopt healthier lives through in-school nutrition and PA promotion. The program provides various resources and includes: ten different healthy eating and PA Playbooks, up to \$4,000 in available grants, and NFL rewards to enrolled schools. All of the healthy eating and PA promotion plans are equipped with additional resources which can be customized for schools to implement. The programs emphasize the leadership of educators as well as the engagement of parents and communities to collectively create healthy eating and PA awareness for students through events and activities.

Another program, the NFL Play 60 Challenge, was created through collaboration with the American Heart Association with the goal of promoting the recommended daily 60 minutes of PA for kids in school and at home. It provides a Teacher Guide that includes ideas, tips, and directions about how to implement a 4-week PA Challenge in school and how to engage students. Supplemental materials are also available, including Student Game Planner for students to track their PA minutes; online Trackers for teachers to track their students PA minutes; online platform where the enrolled school can compete with other schools across the country; fun and creative ways to promote the 4-week PA Challenge; more than 60 subject-based lesson plans;

over 100 PA breaks and homework assignments; take home resources for parents; and ideas on how to incorporate PA in the classroom.

The adoption and use of these two NFL PLAY 60 programs is determined based on an annual survey conducted at the end of each academic year. Questions are asked such as, “Did you participate in the Fuel Up to Play 60 (NFL PLAY 60 challenge) program sponsored by the National Dairy Council (American Heart Association) this past year?”. Schools were coded as 1 or two depending on the number of programs they adopted per year. For example, schools that reported implementing both the NFL Play 60 Challenge program and the Fuel Up to Play 60 programs were coded with a score of “2”. The scores obtained at each year were then summed to create a composite score and schools with scores equal or greater than 3 were identified as being participating schools (the programming implementation point(s) ranged from 0 to 8). The cut off values of 3 points were selected to guarantee that programming schools were enrolled in the programs for at least two years.

### Confounding Factors

Schools were not randomly assigned to either participate or not participate in the programs. As a consequence, there may be differences between the schools characterized as “NFL Programming Schools” and the “Non-Programming Schools” that may be related to the outcome variables examined here. For example, it might be that schools choosing to participate have a greater number of physical education teachers. If so, any differences found between the two types of programming schools may, in fact, reflect the impact of having more PE teachers on these outcome variables rather participating in the programs.

To examine this issue we assessed a number of characteristics of the schools that could be related to both participation in the programs and the level of student fitness. Potential



confounding factors were assessed with baseline survey or national education database. Recent studies have indicated that socioeconomic status of the school is related to measures of student fitness [15, 16]. The percentage of students who were eligible for free and/or reduced lunch was obtained through the National Center for Education Statistics and used as the proxy indicator of socioeconomic status (SES) of the schools.

Other possible confounding factors were measured as part of the baseline survey completed by teachers when their schools were first enrolled in the study. We determined the number of PE teachers at each school by including two questions in the baseline survey: 1) “How many teachers in this school building are designated as physical education teaching staff?”, and 2) “How many physical education teachers in this school building hold a physical education teaching certificate?”. The answer to the first question was converted to three strata of either 1-2 teachers (coded as “1”), 3-4 teachers (coded as “2”), and 5 or more teachers (coded as “3”). The second question was coded to reflect the actual number of teachers that held a PE teaching certificate.

Information regarding the extent of PE programming at the school was assessed using PE class duration, teaching load, and PE class size. PE class duration was assessed using a composite score that reflected both the length and frequency of PE classes. The cutoff values for PE duration per week were set as <90 minutes/week (coded as 1),  $\geq 90$  minutes but <150 minutes/week (coded as 2),  $\geq 150$  minutes but <225 minutes/week (coded as 3), and  $\geq 225$  minutes/week (coded as 4). Teaching load was measured by the following question: “What is your typical teaching load or total number of classes that you teach per day?”. Responses were coded from 1 to 3 to represent 1-2, 3-4, and 4 or more classes per day. Class size was measured by a similar question (“What is the estimated number of students in each physical education

class?") with the responses were coded such that 1 to 4 to represent less than 25, 26-50, 51-75, and 76 or more students in each class.

School health/wellness policies and practices prior to joining the project were measured at baseline. Questions included items asking whether the school conducts annual fitness testing (1=yes, 0=no), whether the school has ever participated in any NFL PLAY 60 activities or programs (1=yes, 0=no), whether the school conducts other non-NFL Play 60 school-wide activity promotion programs (1=yes, 0=no), and whether the school has a wellness council that oversees school nutrition (e.g., vending and school lunch) and PA programs (e.g., recess, after school) (1=yes, 0=no).

### Statistical Analysis

Aerobic capacity and BMI profiles are strongly impacted by gender and therefore in order to facilitate interpretation all the analyses were stratified and presented separately by gender for AC and BMI and, using SAS V.9.4 (Cary, NC: SAS Institute Inc). Baseline means and standard deviations were first computed for AC and BMI HFZ achievements. This descriptive information was stratified by gender, the year they were on the program, and whether the program participation. Descriptive statistics of school SES and other possible confounding factors measured as part of the baseline assessments were also reported. A growth curve modeling analysis was conducted to evaluate whether group-level trajectories of youth fitness (i.e., grade level HFZ achievement of aerobic capacity and BMI, respectively) differed according to program implementation after controlling for time-invariant variables (i.e., the possible confounding factors). A series of hierarchical models were fit to the data to estimate the rate of changes over time (slope) and baseline scores of youth fitness (intercept) between programming and non-programming schools after controlling for the possible confounding factors. Model 1

was the unconditional means model, which was conducted to estimate variability in mean percent AC/BMI HFZ achievement. Model 2 was an unconditional growth model to estimate how the time variable (Year 1 to Year 4) predicted variation in AC/BMI HFZ achievement. Model 3 examined how adoption of one of the programs predicted between-grade variability in AC/BMI HFZ achievement rates. Model 4 added the hypothesized confounding variables to Model 3, (i.e., school SES, school PE teacher demographic, PE programs, and PA-related policies and practice) to determine if the impact of program adoption on AC/BMI HFZ achievement would maintain. All of the confounding variables except for school SES were entered as fixed intercept effect level-2 predictors to control for baseline difference in the outcome variables. School SES was centered to facilitate the interpretation of results and entered as both fixed intercept and slope effects as a level-2 predictor. The assumption of a linear school-level change trajectory was checked using an empirical growth plot. A quadratic year variable was also initially tested but it was deemed not statistically significant and therefore, not included in the model. As a follow up analysis, schools with 4 years of data were coded as the complete data schools and schools with 2 or 3 years of data were coded as incomplete data schools. The interaction effects of having complete data, year, and programming were also tested on the basis of model 4 to examine the dose-effect of programming.

## **Results**

There were 184 elementary, 239 middle, and 74 high schools in the final sample. Of the 497 schools, 95 (19.11%) qualified as programming schools and the remaining 402 represented non-programming schools. Table 1 presents descriptive statistics for the possible confounding factors separately for the programming and non-programming schools. The programming and non-programming schools were similar in SES with an average of 50% of students eligible for

free and reduced lunch in both types of schools. Non-programming schools tended to have more PE teachers and more certified teachers. A slightly higher proportion of non-programming schools (49.8%) had at least 150 minutes /week PE compared to programming schools (46.3%). Teaching load was marginally higher in non-programming schools where 82.3% of teachers had 4 or more classes to teach daily, whereas this percentage was 76.8% for programming schools. The distribution of class size was similar for the two groups of schools. The programming schools had better school health policy and practice; 90.1% of programming schools included fitness testing in PE prior to enrollment in the project compared to 85.0% of the non-programming schools. Similarly, 53.5% and 72.4% of programming schools had implemented NFL PLAY 60 programs and other PA promotion programs before they were recruited; by contrast, 28.2%, and 52.2% of non-programming schools had implemented NFL PLAY 60 programs and other PA promotion programs before they were recruited. Finally, slightly more than half of the schools from both groups had a school wellness council.

Table 2 represents the descriptive AC and BMI HFZ achievement from year 1 to 4 for programming and non-programming schools separately for boys and girls. Among the boys in programming schools, the AC HFZ achievements increased from 64.75% to 71.99% from Year 1 to Year 4, whereas the rate of AC HFZ achievement increased from 64.13% to 66.13% from Year 1 to Year 4 in non-programming schools. The rate of AC HFZ achievement was lower in girls compared to boys but the pattern of change over time was similar in both genders. The BMI HFZ profiles for boys remained stable over the first three years (range from 59.14% to 59.67%) but increased to 63.14% among programming schools in Year 4. However, boys BMI HFZ in non-programming schools fluctuated between 59.61% and 60.87% over the four year period of time. BMI HFZ achievements in girls from programming schools changed from 59.71% to

64.17% between Year 1 to Year 4 whereas their counterparts in non-programming schools remained around 61.5% in Years 1 to 3 but increased to 63.51% in Year 4.

#### Longitudinal changes in AC

The growth curve modeling results for AC HFZ achievement are presented in Table 3. For girls, the annual change in AC HFZ among non-programming schools was 1.08% (SE=0.51%,  $p < 0.01$ ) whereas the annual change for programming schools was 3.03% (SE= 0.91,  $p < 0.01$ ) higher than non-programming schools, which was statistically significant (Model 4). Among boys, the change in non-programming schools was -0.06% (SE=0.48%,  $p > 0.05$ ) per year but the difference between the two groups was 2.87% (SE= 0.84%,  $p < 0.01$ ), which indicating the annual change in achieving AC HFZ for programming schools was 2.81% (Model 4).

#### Impact of other variables for the baseline and change of AC

The controlling for the potential confounding variables of school characteristics did not alter the longitudinal programming effectiveness on AC HFZ in either girls or boys (Compared Model 4 to Model 2). SES was the only statistically significant moderator of the impact of programming on students AC. This effect was limited to boys and demonstrated that one standard deviation increase in free and reduced lunch percentage was associated with a 1.03% (SE=0.36%,  $p < 0.01$ ) increase in annual AC HFZ. There was an interesting trend among schools that had complete 4-year data. For girls, the coefficient of interaction incomplete\*program\*time and incomplete\*time were -2.00% and 0.23%, indicating that programming schools enrolled in 4 years had better programming effect (1.77%/year) trajectory than schools enrolled in 2 or 3 years, although this was not statistically significant. These trends were similar in boys. There was a tendency for better outcomes for boys enrolled in schools with longer enrollment in the project. The AC HFZ trajectories among boys from programming schools enrolled in 4 years

improved by 0.83% per year ( $\beta_{\text{incomplete}*\text{program}*\text{time}}=-0.51\%$  and  $\beta_{\text{incomplete}*\text{time}}=-0.32\%$  based on Model 4) than boys from programming schools enrolled in 2 or 3 years.

A few of confounding variables were found to be associated with significantly different baseline AC HFZ achievements between programming and non-programming schools. Girls from low SES, schools without previous PA promotion programs implementation, and high schools (compared to elementary schools), and teachers had more than 2 classes per day (compared to 1~2 classes per day) had significantly lower baseline AC HFZ achievements. Girls from schools had PE longer than 225 minutes/week had statistically significant higher baseline AC HFZ achievements than their peers had less than 90 minutes/week PE. Boys from low SES schools, high school (compared to elementary schools), teachers teach 3~4 classes (compared to 1~2 classes per day), enrolled in the project for less than 4 years achieved significant lower baseline AC HFZ. Boys from schools with a PE class size between 26 to 50 (compared to less than 25) had significant higher baseline AC HFZ.

#### Longitudinal changes in BMI

Table 4 shows the growth curve analysis results in BMI HFZ achievement among programming and non-programming schools separately for girls and boys. The overall programming effect in BMI statistically significant but was of lower magnitude when compared to the impact on AC HFZ achievement rates. For both girls and boys, little annual changes were found among non-programming schools for BMI HFZ achievement ( $\beta=-0.06\%$ ,  $SE=0.31\%$ ,  $p>0.05$  in girls;  $\beta=-0.21\%$ ,  $SE=0.31\%$ ,  $p>0.05$  in boys) but the boys in programming schools achieved 1.27% ( $SE=0.54\%$ ,  $p<0.05$ ) and girls, 1.19% ( $SE=0.55\%$ ,  $p<0.05$ ) higher BMI annual changes.

#### Impact of other variables for the baseline and change of BMI

Similarly, the inclusion of the confounding variables of school characteristics did not change the longitudinal programming effectiveness on BMI HFZ in either girls or boys (Compared Model 4 to Model 2 in table 4). The examination of the moderation effects of school demographics (i.e., Model 4) revealed that SES was the only statistically significant moderator of the impact of the programs and this effect was also limited to girls. Girls in low SES programming schools had 0.57% ( $\beta_{\text{SES*time}}=-0.33\%$  and  $\beta_{\text{SES*time*Program}}=0.90\%$ ) higher annual change in BMI HFZ than girls in high SES programming schools.

Some confounding variables were found significant in explaining the variation in baseline BMI HFZ achievements. Students from low SES and teachers with higher teaching load had significantly lower baseline BMI HFZ. Additionally, girls from middle school (compared to elementary schools) and schools implemented other PA programs had significantly lower baseline BMI HFZ but girls from schools have wellness council and class size is 26-50 compared to class size of less than 25 achieved significantly higher baseline BMI HFZ. High school boys achieved significantly higher baseline BMI HFZ compared to elementary boys and boys from schools offer 225 minutes/week PE (compared to 90 minutes/week) had significantly lower baseline BMI HFZ.

Figure 1 and 2 illustrates the predicted AC and BMI trajectories based on model 4 for programming and non-programming schools, respectively. All of the programming groups showed positive AC and BMI trajectories for both genders. The non-programming schools either had a plateau trend in AC and BMI trajectories except for AC trajectories among girls that a positive trajectory was revealed.

## Discussion

The present study suggests that school implementation of NFL PLAY 60 programming was associated with the improvement of youth fitness profiles over time, even after adjusting for school demographic characteristics as well as health and PE policies. There was evidence of a dose-response relationship that the longer schools implemented the programs, the better fitness outcome they achieved. Findings also revealed that the programming effectiveness was stronger in AC than BMI.

The magnitude of the effects are noteworthy considering the distributed nature of the programming and the participatory nature of the design. Although a large number of school-based intervention programs have been conducted in school settings over the past decades, the magnitudes of treatment effects are generally small across different programs [17]. Small and/or nonsignificant decrease in BMI among children and adolescents have been reported in most school-based programming interventions, which was concluded by several comprehensive meta-analysis reviews [18, 3, 19]. Surprisingly, no meta-analysis review has been conducted with the cardiovascular fitness as the programming outcome measure but the relatively consistent findings from the systematic reviews, suggest that school-based intervention have moderate programming effects on children and adolescents cardiovascular fitness [5, 4, 3, 20]. For instance, in the most recent meta-analysis, Guerra et al. reported non-significant standardized means difference of -0.03 in BMI between intervention and control groups after reviewing 38 intervention studies conducted in school settings [20]. The current study demonstrated that adopting the health enhancement programs had greater effects on youth aerobic fitness and BMI profiles compared to previous research. Notably, increases of approximately 2.5% in AC and 1% in BMI HFZ achievement per year were found among programming schools in contrast to non-



programming schools. Given that nearly 100 schools adopted the programs these results collectively impact thousands of students. Moreover, greater progress in AC compared to BMI was observed in our study that was consistent with previous research.

The other challenge in public health is how to translate efficacious interventions into practice in order to combat childhood obesity and physically inactive behaviors [21]. Most of the published randomized controlled trials have emphasized internal validity. However, this limits the generalizability of the results to a broader population, not to mention the sustainability of the intervention once the study has ended [22]. Few evidence-based studies have shown utility when broadly disseminated [8]. Yancey et al. pointed out that the program could be broadly disseminated when it is designed to be easily modified with respect to the adopters demographic, geographic, and cultural contexts [23]. The current study applies a similar approach to that mentioned above by introducing a practice in a less controlled manner. The project empowered the participating school communities to develop a school health promotion plan and coordinate their resources and personnel that lead to a healthy school environment (PA or nutrition oriented). Both Fuel Up to Play 60 and Play 60 challenge are multi-level and multi-component promotion programs, providing banks of PA breaks in the classroom, subject-based lesson plans, and healthy eating and PA promotion plans from which school stakeholders can choose and adopt the ones in compliance with their school policies and interests. The current programs provide simple strategies, tools, checklists, and resources to allow schools to take action on their own. The findings support the utility of these less structured programs under real world conditions. The current study also confirm that multilevel school-driven programs are more efficacious than individual and/or interpersonal PA interventions [24, 6].

This research fills gaps in the evaluation of school-based healthy eating and PA programs under real-world conditions. A large number of PA and nutrition oriented promotion programs are supported by government and non-governmental organizations (e.g., healthcare, philanthropy foundation, nonprofit organization, and private sector) [25]. For example, First Lady Michelle Obama launched collaborative and community-oriented initiative Lets move! in 2010 to combat the epidemic of childhood obesity. As one of the ten sub-initiatives, Lets Move! Active Schools has enrolled over 14,000 schools across the country in 5 years [9]. The Lets Move!, has promoted awareness about the importance of PA and good nutrition for youth and the NFL PLAY 60 programs have had a similar impact through their national brand and associated school-based programs. However, it has proven difficult to quantify the impact of these programs because of the lack of systematic evaluation methods and measurable outcomes. This study filled that gap by linking programming status to school level outcomes collected using the web-based FITNESSGRAM program. The examples of the methods used in this study provide examples for how other programs can be systematically evaluated. Considering the large scale of FITNESSGRAM adoption [26], similar work can be done to evaluate other programs implemented in real-world settings.

Several limitations of the present study should be noted. First, as the two programs are suggestive but not required by the project, the overall adoption rate is low. The next phase of the project focuses on increasing the implementation of the programs by creating impact schools in the current cohort with additional funding and training. We combined the two programs in our analyses due to the relatively low implementation rate. Future work could be done to study the independent effect of the two programs as they emphasize different aspects of youth health. Second, this is not a randomized controlled trial design that limits the causal conclusions of the

programming effectiveness. It is possible there are other policies changing within schools or other programs that the schools implemented rather than the two programs suggested by the project. Finally, group level aggregated data were used to evaluate the changes in youth fitness in the current study because the project was design to operate by teachers and students taught by the same teacher received similar programs. Future research are needed to examine the program impact at individual level, especially among the obese kids.

## **Conclusion**

This is the first study to examine the longitudinal impact of prominent school-based programming (two key NFL PLAY 60 programs) when implemented under real-world conditions. The longitudinal design enables us to directly compare programming schools to non-programming schools and to test the sustainability over time. The substantial improvement in youth aerobic capacity and weight profile, as well as the large scale of schools and students participation, illustrates the overall program impact.

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Table 1. Descriptive characteristics of school demographic, physical education programs and school health policy

Variables		Programming		Non-programming	
		Mean	SD	Mean	SD
Socioeconomic Status		0.50	0.24	0.48	0.28
		Frequency	Percentage	Frequency	Percentage
Number of PE Teacher	1~2	71	74.7	274	68.7
	2~3	21	22.1	81	20.3
	5 or more	3	3.2	44	11
Number of Certified Teachers	0	1	1.1	4	1
	1	42	44.7	161	40.8
	2	26	27.7	102	25.8
	3	11	11.7	43	10.9
	4	11	11.7	32	8.1
	5	3	3.2	53	13.4
	≥90	30	31.6	99	24.6
PE Duration (minutes/week)	≥90 but <150	21	22.1	103	25.6
	≥150 but <225	14	14.7	77	19.2
	≥225	30	31.6	123	30.6
Teaching Load (per day)	None	0	0	6	1.5
	1~2	4	4.2	8	2
	3~4	18	19	62	15.5
	4 or more	73	76.8	325	81.1
	less than 25	35	36.8	120	30.5
Class Size	26~50	50	52.6	230	58.4
	51~75	9	9.5	42	10.7
	76 or more	1	1.1	2	0.5
	Yes	82	90.1	328	85
Previous Fitness Testing	No	9	9.9	58	15
	Yes	46	53.5	102	28.2
Previous Participation in NFL PA Programs	No	40	46.5	260	71.8
	Yes	63	72.4	199	52.2
Previous Participation in other PA programs	No	24	27.6	182	47.8
	Yes	45	47.4	186	46.3
School Wellness Council	No	50	52.6	216	53.7

Abbreviations: SD, Standard Deviation; PA, Physical Activity; PE, Physical Education; Incomplete, Schools with 2 or 3 years fitness data.

Table 2. Descriptive aerobic capacity and body mass index Healthy Fitness Zone achievements in year 1 to 4

	Boys				Girls			
	Programming Schools		Non-programming Schools		Programming Schools		Non-programming Schools	
	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)
AC								
Year 1	204	64.8 (21.9)	832	64.1 (22.0)	205	53.0 (27.2)	816	52.2 (26.3)
Year 2	226	66.8 (22.1)	863	62.9 (22.2)	221	57.0 (25.7)	842	52.0 (25.9)
Year 3	144	71.9 (20.0)	467	63.3 (21.9)	141	60.8 (25.8)	455	54.3 (26.2)
Year 4	64	72.0 (22.7)	175	66.1 (20.2)	62	65.4 (23.8)	173	57.7 (24.1)
BMI								
Year 1	245	59.1 (12.3)	927	60.0 (13.5)	915	59.7 (13.1)	245	61.8 (14.5)
Year 2	249	59.7 (13.8)	945	60.6 (13.0)	928	59.7 (13.9)	244	61.5 (14.8)
Year 3	158	59.4 (13.7)	515	59.6 (12.9)	503	62.1 (13.5)	155	62.0 (14.5)
Year 4	71	63.1 (12.2)	195	60.9 (12.1)	193	64.2 (13.6)	69	63.5 (13.0)

Abbreviations: SD, Standard Deviation; AC, Aerobic Capacity; BMI, Body Mass Index.



Table 3. Growth curve model results in longitudinal program effects on aerobic capacity Healthy Fitness Zone achievement.

	Girls					Boys				
	Null Model	Model 1	Model 2	Model 3	Model 4	Null Model	Model 1	Model 2	Model 3	Model4
Intercept	52.86 (0.71)**	51.15 (0.79)**	50.79 (0.88)**	53.01 (6.79)**	54.71 (6.97)**	64.07 (0.59)**	63.55 (0.66)**	63.41 (0.74)**	66.93 (5.74)**	68.23 (5.91)**
Program			1.80 (1.95)	0.80 (1.95)	2.40 (2.22)			0.69 (1.64)	1.14 (1.71)	1.47 (1.96)
SES				-11.26 (0.82)**	-11.23 (0.82)**				-8.46 (0.71)**	-8.48 (0.71)**
Number certified teacher				1.37 (1.01)	1.40 (1.01)				0.84 (0.85)	0.81 (0.85)
Previous Fitness Testing				2.50 (2.04)	2.46 (2.04)				1.53 (1.74)	1.52 (1.74)
NFL PA Programs				-1.75 (1.59)	-1.55 (1.59)				-2.49 (1.33)	-2.36 (1.34)
Other PA programs				3.18 (1.55)*	3.10 (1.55)*				1.92 (1.31)	1.87 (1.31)
School Wellness Council				2.77 (1.43)	2.79 (1.43)				2.66 (1.20)*	2.72 (1.20)
Age group										
Elementary School				Ref	Ref				Ref	Ref
Middle School				-1.95 (1.64)**	-2.30 (1.65)				-0.92 (1.37)	-1.13 (1.38)
High School				-14.16 (2.82)**	-14.35 (2.82)**				-12.44 (2.35)**	-12.56 (2.35)**
Number PE teacher										
1~2 teachers				Ref	Ref				Ref	Ref
2~3 teachers				2.94 (2.45)	3.14 (2.45)				0.44 (2.08)	0.52 (2.08)
5 or more teachers				5.95 (4.14)	5.82 (4.14)				5.24 (3.53)	4.97 (3.54)
PE Duration (minutes/week)										
<90				Ref	Ref				Ref	Ref
≥90 but <150				1.64 (2.02)	1.58 (2.02)				-0.48 (1.70)	-0.63 (1.71)
≥150 but <225				1.29 (2.44)	1.07 (2.46)				-0.65 (2.05)	-0.90 (2.07)
≥225				4.57 (2.08)*	4.73 (2.08)*				1.51 (1.74)	1.53 (1.74)
Teaching Load (per day)										
1~2 classes				Ref	Ref				Ref	Ref
3~4 classes				-16.06 (5.39)**	-16.77 (5.39)**				-10.45 (4.54)*	-10.73 (4.55)*
4 or more classes				-11.32 (5.17)*	-11.88 (5.17)*				-7.91 (4.35)	-8.08 (4.36)
Class Size										
less than 25				Ref	Ref				Ref	Ref
26~50				0.80 (1.63)	1.28 (1.64)				1.17 (1.37)*	1.38 (1.38)*
51~75				3.08 (2.77)	3.73 (2.78)				1.82 (2.32)*	2.20 (2.34)
76 or more				-8.52 (8.17)	-8.35 (8.16)				-13.76 (7.42)	-13.74 (7.43)
Incomplete					-1.99 (2.13)					-0.84 (1.91)*
					Rate of Change					
Intercept (Time)		1.79 (0.34)**		1.25 (0.40)**	1.08 (0.51)*		0.52 (0.31)		-0.15 (0.37)	-0.06(0.48)
Program			2.53 (0.80)**	2.35 (0.82)**	3.03 (0.91)**			2.78 (0.73)**	2.76 (0.78)**	2.87 (0.84)**
SES				0.27 (0.39)	0.26 (0.39)				1.01 (0.36)**	1.03 (0.36)**
SES*Program				1.19 (0.78)	1.14 (0.79)				-0.03 (0.72)	-0.06 (0.72)
Incomplete					0.23 (0.63)					-0.32 (0.58)
Incomplete*Program					-2.00 (1.10)					-0.51 (0.97)
					Variance Components					
Residual	209.6 (7.03)**	186.64 (8.19)**	186.96 (8.20)**	170.05 (8.10)**	169.99 (8.10)**	174.02 (5.76)**	155.30 (6.62)**	154.95 (6.57)**	148.68 (6.87)**	148.45 (6.85)**
Random Effects										
Level-one variance	481.68 ( 24.37)**	526.78 (30.17)**	526.36 (30.16)**	403.86 (34.07)**	403.98 (34.14)**	315.45 (16.60)**	353.98 (21.38)**	355.52 (21.44)**	309.20 (26.89)**	310.23 (26.98)**
Level-two variance		16.77 (5.42)**	15.41 (5.34)**	13.93 (4.94)**	14.09 (4.96)**		15.79 (4.33)**	15.03 (4.22)**	16.37 (4.35)**	16.56 (4.37)**
					Goodness-of-fit					
Deviance	25987	25939.3	25918.3	21264.5	21253.2	25730.7	25708.3	25683.8	21186.7	21179.1
AIC	25991	25947.3	25926.3	21272.5	21261.2	25734.7	25716.3	25691.8	21194.7	21187.1
BIC	26001.4	25968.1	25947.1	21292.7	21281.3	25745.2	25737.1	25712.6	21214.9	21207.2

\*\* Coefficient estimation is significant at an alpha level of 0.01 (2-tailed). \* Coefficient estimation is significant at an alpha level of 0.05 (2-tailed).

Abbreviations: SES, Socioeconomics Status; PA, Physical Activity; PE, Physical Education; Incomplete, Schools with 2 or 3 years fitness data.

Table 4. Growth curve model results in longitudinal program effects on body mass index Healthy Fitness Zone achievement.

	Girls					Boys				
	Null Model	Model 1	Model 2	Model 3	Model 4	Null Model	Model 1	Model 2	Model 3	Model 4
Intercept	61.36 (0.34)**	60.95 (0.39)**	61.40 (0.44)**	67.35 (3.07)**	67.00 (3.13)**	60.02 (0.29)**	59.83 (0.35)**	60.09 (0.40)**	67.70 (2.91)**	67.18 (2.97)**
Program			-2.08 (0.95)*	-1.01 (0.92)	-1.15 (1.07)			-1.20 (0.86)	-0.60 (0.87)	-0.02 (1.02)
SES				-6.88 (0.38)**	-6.89 (0.39)**				-4.29 (0.37)**	-4.29 (0.37)**
Number certified teacher				0.12 (0.45)	0.11 (0.46)				-0.25 (0.43)	-0.23 (0.43)
Previous Fitness Testing				-5.38 (3.87)	-5.41 (3.87)				-7.00 (3.59)	-6.97 (3.60)
NFL PA Programs				-0.47 (0.88)	-0.50 (0.88)				-1.06 (0.83)	-1.11 (0.84)
Other PA programs				-1.89 (0.68)**	-1.93 (0.68)**				-0.16 (0.64)	-0.15 (0.65)
School Wellness Council				0.92 (0.67)*	0.95 (0.68)				-0.53 (0.64)	-0.53 (0.64)*
Age group										
Elementary School				Ref	Ref				Ref	Ref
Middle School				-2.56 (0.71)**	-2.49 (0.72)**				0.47 (0.67)	0.48 (0.67)
High School				0.22 (1.23)	0.25 (1.24)				3.15 (1.16)**	3.08 (1.16)**
Number PE teacher										
1~2 teachers				Ref	Ref				Ref	Ref
2~3 teachers				0.81 (1.12)	0.76 (1.12)				0.12 (1.06)	0.11 (1.06)
5 or more teachers				1.81 (1.84)	1.84 (1.84)				1.53 (1.73)	1.67 (1.74)
PE Duration (minutes/week)										
<90				Ref	Ref				Ref	Ref
≥90 but <150				-0.82 (0.85)	-0.78 (0.85)				-0.78 (0.80)	-0.66 (0.80)
≥150 but <225				-0.94 (1.06)	-0.87 (1.07)				-1.15 (1.00)	-0.99 (1.01)
≥225				-1.74 (0.88)	-1.77 (0.89)*				-2.75 (0.83)**	-2.70 (0.84)**
Teaching Load (per day)										
1~2 classes				Ref	Ref				Ref	Ref
3~4 classes				-5.44 (2.48)*	-5.33 (2.49)*				-4.71 (2.35)*	-4.76 (2.36)*
4 or more classes				-4.74 (2.38)*	-4.65 (2.38)				-4.73 (2.26)*	-4.78 (2.26)*
Class Size										
less than 25				Ref	Ref				Ref	Ref
26~50				1.76 (0.69)*	1.67 (0.70)*				-0.45 (0.65)	-0.41 (0.66)
51~75				1.19 (1.26)	1.06 (1.27)				-1.55 (1.20)	-1.60 (1.21)
76 or more				-5.38 (3.87)	-5.41 (3.87)				-7.00 (3.59)	-6.97 (3.60)
Incomplete					-1.99 (2.13)					-0.84 (1.91)*
					Rate of Change					
Intercept (Time)		0.44 (0.21)*	0.19 (0.24)	-0.07 (0.26)	-0.06 (0.31)		0.20 (0.21)	0.03 (0.24)	-0.16 (0.26)	-0.21 (0.31)
Program			1.05 (0.48)*	1.30 (0.53)*	1.27 (0.54)*			0.76 (0.50)	1.05 (0.54)*	1.19 (0.55)*
SES				-0.33 (0.26)	-0.33 (0.26)				-0.04 (0.26)	-0.06 (0.26)
SES*Program				0.90 (0.46)*	0.90 (0.50)				-0.004 (0.46)	0.02 (0.46)
Incomplete					0.06 (0.37)					0.27 (0.36)
Incomplete*Program					0.19 (0.57)					-0.59 (0.56)
					Variance Components					
Residual	103.59 (3.29)**	103.48 (3.29)**	103.30 (3.28)**	97.83 (4.17)**	97.87 (4.18)**	110.51 (3.48)**	108.70 (4.16)**	108.87 (4.17)**	110.12 (4.53)	109.98 (4.53)**
Random Effects										
Level-one variance	102.66 ( 6.00)**	103.91 (7.55)**	103.40 (7.54)**	59.80 (9.82)**	59.93 (9.84)**	63.17 (4.60)**	65.72 (7.08)**	65.35 (7.08)**	29.83 (8.46)	30.61 (8.51)**
Level-two variance				3.26 (2.08)	3.26 (2.08)		1.62 (2.16)	1.41 (2.16)	1.26 (2.13)	1.23 (2.13)
Goodness-of-fit										
Deviance	25882.2	25879	25870.9	21145	21142.5	26060.3	26060.1	26055.8	21531.7	21528.4
AIC	25886.2	25885	25876.9	21153	21150.5	26064.3	26068.1	26063.8	21539.7	21536.4
BIC	25896.6	25900.7	25892.5	21173.1	21170.6	26074.8	26089	26084.6	21559.8	21556.5

\*\* Coefficient estimation is significant at an alpha level of 0.01 (2-tailed). \* Coefficient estimation is significant at an alpha level of 0.05 (2-tailed).

Abbreviations: SES, Socioeconomics Status; PA, Physical Activity; PE, Physical Education; Incomplete, Schools with 2 or 3 years fitness data.

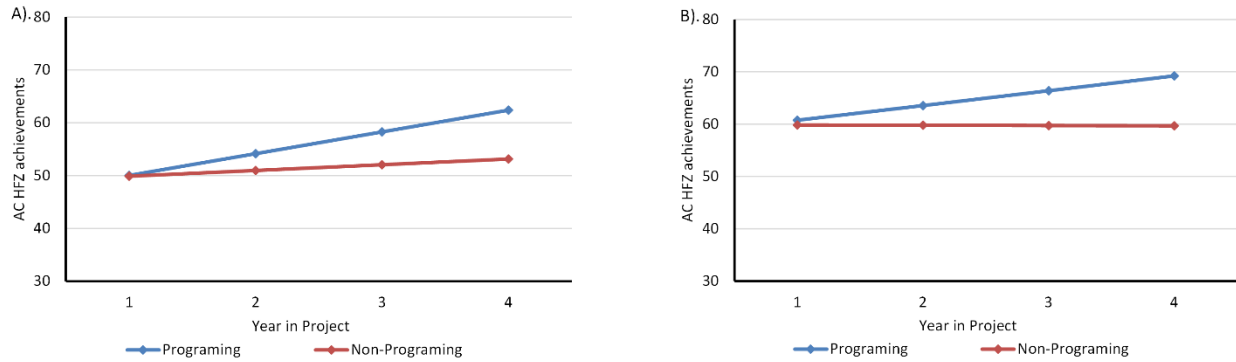


Figure 1. The predicted 4-year aerobic capacity Healthy Fitness Zone achievement by program implementation for A, boys and B, girls.

Abbreviations: AC, Aerobic Capacity; HFZ, Healthy Fitness Zone; SES, Socioeconomics Status; Programming, Schools were identified as programming schools; Non-Programming, Schools were identified as non-programming schools.

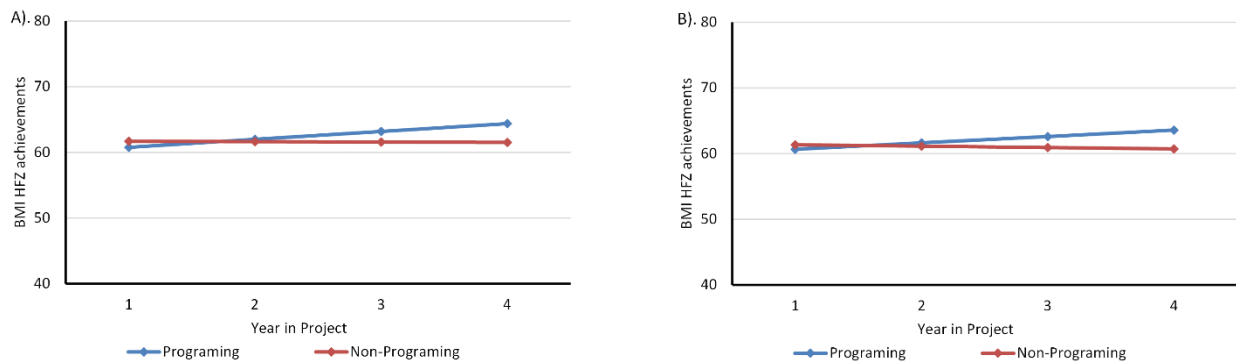


Figure 2. The 4-year body mass index Healthy Fitness Zone achievement least square means by program implementation for A, boys and B, girls.

Abbreviations: BMI, Body Mass Index; HFZ, Healthy Fitness Zone; SES, Socioeconomics Status; Programming, Schools were identified as programming schools; Non-Programming, Schools were identified as non-programming schools.

## CHAPTER 6. CONCLUSION

The three studies presented in the dissertation advanced the research in youth fitness surveillance and physical activity promotion program evaluation using large scale youth physical fitness data at national and statewide level. Youth fitness surveillance was directly evaluated in Texas Youth Fitness Study. Small but positive changes were observed in body mass index over four years from Texas children and adolescents whose fitness was measured as part of the state mandate. The physical fitness test was administered by trained physical education teachers across Texas and approximately 2-3 million of youth were measured each year. By combining data from other school and county resources, a number of school level and county level contextual correlates including school socioeconomic status, enrollment, county adult obesity, food environment index, college completion, and income inequality were identified as significant determinants that may explain disparities in youth obesity rates. The results from this study have direct value to explain patterns in Texas but they also offer insights about patterns that may hold in other states or on a national level. More importantly, the results provide examples of how FITNESSGRAM data can be systematically evaluated to advance public health surveillance.

The program evaluation was performed with fitness data collected through NFL PLAY 60 FITNESSGRAM Partnership Project over four years. Significant longitudinal improvement in percentage of students achieving the FITNESSGRAM standards were observed in two important fitness indicators, aerobic capacity and body mass index, among students from schools adopted the healthy eating and physical activity promotion programs. The fitness testing and health enhanced programs were administered by local school teachers and leaders in real-world settings with support from research team. The substantial youth fitness improvement in a four years span are noteworthy considering the naturalistic nature of the design and the scope of the project.

The present dissertation work provides unique perspective in advancing the research and application of youth fitness. It supports the utility of teacher collected youth fitness information as part of physical education program but also an important surveillance element in public health agenda to provide healthy environment for children and adolescents.

Both the two projects are still ongoing and there is additional work to accomplish. The next step for the Texas Youth Fitness Study is to continue the longitudinal tracking of youth fitness and examine the health disparity from individual level due to the increasing adoption of FITNESSGRAM 10 in Texas. The next phase of the NFL PLAY 60 FITNESSGRAM Partnership Project focuses on the advocacy of physical activity programs implementation among the nonprogramming schools as well as the continue support to the current cohort. Additionally, it is still not clear that why some schools could successfully implement the activity promotion programs but some not. Future effort and work will pursue to answer these research questions.

## APPENDIX A. NFL PLAY 60 FITNESSGRAM PROJECT IRB



April 06, 2010

Dr Charles Sterling  
The Cooper Institute

**Re: NFL Play 60 / FitnessGram Project**

**Approval # 10-08**

Dear Dr. Sterling:

The IRB grants initial approval to the above-referenced project. As this work will be performed as a part of the regular curriculum, there were no perceived overdue risks to the participants.

If there are further changes to any of the project materials, these must be presented and approved by the IRB before implementation.

Please remember that annual review is due on or before April 05, 2011, OR a final report is due at the completion of the work, whichever comes first.

Please contact me at [mmorrow@cooperinst.org](mailto:mmorrow@cooperinst.org) or 972 341 3247 if there are questions.

Sincerely,

Melba Morrow  
Administrator, Institutional Review Board

## **APPENDIX B. NFL PLAY 60 FITNESSGRAM PROJECT BASELINE SURVEY**

**Q1** This survey provides NFL PLAY 60 and The Cooper Institute with valuable information about physical education and activity programs around the country. This tool is also important for collective efforts used to promote physical activity to decrease childhood obesity. All survey data and results (i.e., reports, publications, and presentations) will be de-identified to protect the confidentiality of schools and individuals. If you are involved in multiple locations, a survey must be completed for each site (school / organization). It is important to completely answer all relevant questions and to provide accurate answers to the best of your ability. This survey should take 20-40 minutes to complete. Thank you for your time.

**Q2 SELECT APPROPRIATE SURVEY:**At what type of site / setting will you be conducting the NFL PLAY 60 FITNESSGRAM project? Please Note: If you are involved in a combination of schools and organizations choose the appropriate option below that describes the particular site for which you are taking this survey.

- ☐ On-site School Program -- your school or organization will be conducting FITNESSGRAM assessment in a school setting. (1)
- ☐ Off-site Program -- your organization will be conducting FITNESSGRAM assessments only during an after-school or off-site program such as a Boys and Girls Club or YMCA. (2)

**Q3 DIRECTIONS:** This is the beginning of a four section survey. It is important to completely answer all relevant questions and to provide accurate answers to the best of your ability.

**Q4 SECTION 1: Demographic Information**The following questions provide demographic information about your academic training and teaching experiences. It is important to completely answer all relevant questions and to provide accurate answers to the best of your ability.

**Q5** Please select the NFL team you are affiliated with:

(Table Truncated to 63 Columns)

Q6 Please select the state which your school is located in:

Answer If Please select the NFL team you are affiliated with: - Arizona Cardinals Is Selected  
And Please select the NFL team you are affiliated with: - Tennessee Titans Is Selected

Q7 Please enter your official school name (DO NOT ABBREVIATE):

Answer If Please select the NFL team you are affiliated with: - Arizona Cardinals Is Selected  
And Please select the NFL team you are affiliated with: - Washington Redskins Is Selected

Q8 Please enter the district your school is associated with:

Q9 School Type:

- ☐ Elementary school (1)
- ☐ Middle school (2)
- ☐ High school (3)
- ☐ Other (4) \_\_\_\_\_

Q10 Enrollment of participating school:

- ☐ 1-100 (1)
- ☐ 101-300 (2)
- ☐ 301-500 (3)
- ☐ 501-1000 (4)
- ☐ 1000+ (5)

Q11 How many teachers in this school building are designated as physical education teaching staff?

- ☐ 0 (1)
- ☐ 1-2 (2)
- ☐ 3-4 (3)
- ☐ 5 or more (4)



Q12 How many physical education teachers in this school building hold a physical education teaching certificate?

- ☐ 0 (1)
- ☐ 1 (2)
- ☐ 2 (3)
- ☐ 3 (4)
- ☐ 4 (5)
- ☐ 5 or more (6)
- ☐ I don't know (7)

Q13 What is your highest education level completed?

- ☐ High School (1)
- ☐ Bachelor's (2)
- ☐ Master's (3)
- ☐ Specialist (Master's +36) (4)
- ☐ Doctorate (5)
- ☐ Other (6) \_\_\_\_\_

Q14 What is your current position at the school?

- ☐ Physical Education Teacher (1)
- ☐ Classroom Teacher (2)
- ☐ Principal (3)
- ☐ School Nurse (4)
- ☐ Other (5) \_\_\_\_\_

Q15 Are you listed as the primary FITNESSGRAM contact for the NFL PLAY 60/FITNESSGRAM project?

- ☐ Yes, I am the lead contact and handle the correspondence and programming (1)
- ☐ No, we are participating in the project but it will be coordinated by another organization (i.e. YMCA or Boys and Girls Club) (2)
- ☐ No, I am not the primary FITNESSGRAM contact for this project but I am assisting the main FITNESSGRAM contact (3)
- ☐ I don't know (4) \_\_\_\_\_

Q16 You have just completed Section 1 of 4. Please click the next button at the bottom of the page to continue to Section 2.

Q17 SECTION 2: NFL PLAY 60 Programs The following questions relate to NFL PLAY 60 Programming in your school.

Q18 Has your school ever participated in any NFL PLAY 60 activities or programs prior to joining this program?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Answer If Has your school ever participated in any NFL PLAY 60 acti... No Is Selected Or Has your school ever participated in any NFL PLAY 60 acti... I don't know Is Selected

Q192 What is the primary reason you have not participated in any NFL PLAY 60 programs?

- ☐ I was not aware or have not heard about other NFL PLAY 60 programs (1)
- ☐ Cost (2)
- ☐ Time (3)
- ☐ Burden (4)
- ☐ Limited support (5)
- ☐ Policy (6)
- ☐ Other (7) \_\_\_\_\_

Answer If Has your school ever participated in any NFL PLAY 60 acti... Yes Is Selected

Q19 Has your school participated in the NFL PLAY 60 Challenge?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Answer If Has your school ever participated in NFL Fuel Up to PLAY 60? Yes Is Selected

Q20 Rate your overall satisfaction with the NFL PLAY 60 Challenge that you have previously conducted, not including the NFL PLAY 60 FITNESSGRAM project:

- ☐ Very Satisfied (1)
- ☐ Somewhat Satisfied (2)
- ☐ Somewhat Dissatisfied (3)
- ☐ Very Dissatisfied (4)

Answer If Has your school participated in the NFL PLAY 60 Challenge? Yes Is Selected

Q180 Does your school plan to implement NFL PLAY 60 Challenge next year?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Answer If Does your school plan to implement NFL PLAY 60 Challenge ... No Is Selected

Q185 Please indicate the primary reason why your school does not plan on implementing this program again:

- ☐ Cost (1)
- ☐ Time (2)
- ☐ Burden (3)
- ☐ Limited Support (4)
- ☐ Policy (5)
- ☐ Other (6) \_\_\_\_\_

Answer If Has your school ever participated in any NFL PLAY 60 acti... Yes Is Selected

Q187 Has your school ever participated in NFL Fuel Up to PLAY 60?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Answer If Has your school ever participated in NFL Fuel Up to PLAY 60? Yes Is Selected

Q21 Rate your overall satisfaction with the NFL Fuel Up to PLAY 60 that you have previously conducted, not including the NFL PLAY 60 FITNESSGRAM project:

- ☐ Very Satisfied (1)
- ☐ Somewhat Satisfied (2)
- ☐ Somewhat Dissatisfied (3)
- ☐ Very Dissatisfied (4)

Answer If Has your school ever participated in NFL Fuel Up to PLAY 60? Yes Is Selected

Q183 Does your school plan to implement NFL Fuel Up to PLAY 60 next year?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Answer If Does your school plan to implement NFL Fuel Up to PLAY 60... No Is Selected

Q184 Please indicate the primary reason your school does not plan on implementing this program again:

- ☐ Cost (1)
- ☐ Time (2)
- ☐ Burden (3)
- ☐ Limited Support (4)
- ☐ Policy (5)
- ☐ Other (6) \_\_\_\_\_

Answer If Has your school ever participated in any NFL PLAY 60 acti... Yes Is Selected

Q188 Has your school participated in Back to Football/NFL PLAY 60 Super Schools?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Answer If Has your school ever participated in any NFL PLAY 60 acti... Yes Is Selected

Q193 Has your school participated in NFL Flag Football?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Answer If Has your school ever participated in any NFL PLAY 60 acti... Yes Is Selected

Q194 Has your school participated in NFL Girls Flag Football Leadership Program?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Answer If Has your school ever participated in any NFL PLAY 60 acti... Yes Is Selected

Q189 Has your school participated in NFL Punt, Pass, and Kick?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Answer If Has your school ever participated in any NFL PLAY 60 acti... Yes Is Selected

Q190 Has your school participated in NFL ReCharge! Or Mini ReCharge!?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Answer If Has your school ever participated in any NFL PLAY 60 acti... Yes Is Selected

Q191 Has your school participated in NFL Keep Gym in School?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Answer If Has your school ever participated in any NFL PLAY 60 acti... Yes Is Selected

Q195 Has your school participated in Hometown Huddle?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Answer If Has your school ever participated in any NFL PLAY 60 acti... Yes Is Selected

Q196 Has your school participated with HOPSports?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Answer If Has your school ever participated in any NFL PLAY 60 acti... Yes Is Selected

Q197 Has your school participated in any other PLAY 60 programs?

- ☐ Yes (Please enter the name of the program in the box below) (1) \_\_\_\_\_
- ☐ No (2)
- ☐ I don't know (3)

Q223 In the future, if you had the opportunity to choose which of the following NFL PLAY 60 programs would your school be most interested in implementing?

(Table Truncated to 63 Columns)

Q186 Does your school conduct other non-NFL PLAY 60 school-wide activity promotion programs (i.e., walk to school programs, supplemental recess programs, classroom activity breaks, after school programming, etc.)?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Answer If Does your school conduct other non-NFL PLAY 60 school-wid... Yes Is Selected

Q179 On average, how many non-NFL PLAY 60 school-wide activity promotions are implemented per year?

- ☐ 1 (1)
- ☐ 2 (2)
- ☐ 3 (3)
- ☐ 4 or more (4)

Q24 How important do you think regular physical activity and physical education is for your school?

- ☐ Very important (1)
- ☐ Somewhat important (2)
- ☐ Not important (3)

Q25 You have just completed Section 2 of 4. Please click the next button at the bottom of the page to continue to Section 3.

Q26 SECTION 3: PHYSICAL EDUCATION PROGRAMMING AND RECESS The following questions provide information about the amount of physical education and recess that children in your specific school receive. It is important to have complete data so please provide estimates if you are not certain.

Q27 How many days a week do physical education classes usually meet in your school?

- ☐ 1 day a week (1)
- ☐ 2 days a week (2)
- ☐ 1 day one week, 2 days the next week (3)
- ☐ 2 days one week, 3 days the next week (4)
- ☐ 3 days a week (5)
- ☐ 4 days a week (6)
- ☐ 5 days a week (7)
- ☐ Other (please specify) (8) \_\_\_\_\_

Q28 How long is the typical physical education class? (Count time for changing and showering)

- ☐ Less than 20 minutes (1)
- ☐ 20-25 minutes (2)
- ☐ 26-30minutes (3)
- ☐ 31-35 minutes (4)
- ☐ 36-40 minutes (5)
- ☐ 41-45 minutes (6)
- ☐ 46-60 minutes (7)
- ☐ Greater than 60 minutes (8)

Q29 What is your typical teaching load or total number of classes that you teach per day?  
(Estimate to the best of your ability)

- ☐ 0 (1)
- ☐ 1-2 (2)
- ☐ 3-4 (3)
- ☐ 5 or more (4)

Answer If What is your typical teaching load or total number of cla... 1-2 Is Selected Or What is your typical teaching load or total number of cla... 3-4 Is Selected Or What is your typical teaching load or total number of cla... 5 or more Is Selected

Q30 What is the estimated number of students in each physical education class?

- ☐ Less than 25 (1)
- ☐ 26-50 (2)
- ☐ 51-75 (3)
- ☐ 76 or more (4)

Q31 Did the school's Physical Education program include annual fitness testing prior to entering this project?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)



Answer If Did the school's Physical Education program include ann... Yes Is Selected

Q32 What was the primary fitness testing battery used?

- ☐ FITNESSGRAM (1)
- ☐ President's Council on Physical Fitness and Sports (2)
- ☐ YMCA (3)
- ☐ Other: (4) \_\_\_\_\_

Answer If Did the school's Physical Education program include ann... Yes Is Selected

Q33 What is the main use of fitness results in your school?

- ☐ Data required by the state (1)
- ☐ Data required by the district (2)
- ☐ Data used to guide curriculum (3)
- ☐ Data are shared with parents to promote awareness (4)
- ☐ Data are tracked over time to show changes (5)

Q34 Does your school offer recess? (Exclude free time at lunch)

- ☐ Yes (1)
- ☐ No (2)

Answer If Does your school offer recess? (Exclude free time at lunch) Yes Is Selected

Q35 How many periods of recess do students get at your school?

- ☐ 1 (2)
- ☐ 2 (3)
- ☐ 3 or more (4)

Answer If Does your school offer recess? (Exclude free time at lunch) Yes Is Selected

Q36 How long are recess periods at your school?

- ☐ 1-10 minutes (1)
- ☐ 11-20 minutes (2)
- ☐ 21-30 minutes (3)
- ☐ 30+ minutes (4)

Q37 You have just completed Section 3 of 4. Please click the next button at the bottom of the page to continue to Section 4.

Q38 SECTION 4: PHYSICAL EDUCATION POLICIES The following questions provide information about policies related to physical education in your school.

Q39 Did your school complete a formal school policy as part of the USDA School Wellness Policy initiative?

- ☐ Yes (1)
- ☐ No (2)
- ☐ Not sure (3)

Answer If Did your school complete a formal school policy as part o... Yes Is Selected

Q40 Did you serve on the school's wellness committee to help formulate the policy?

- ☐ Yes (1)
- ☐ No (2)

Q41 Does your school have a school wellness council that oversees school nutrition (e.g., vending and school lunch) and physical activity programs (e.g., recess, after school)?

- ☐ Yes (1)
- ☐ Yes, there is a committee, but it does not meet regularly and/or does not provide any structure or guidance (2)
- ☐ No, but there are plans to form one (3)
- ☐ No, and there are no plans to form one (4)
- ☐ I do not know (5)

Q42 Does your school assign grades for physical education courses? Do the grades count as much as grades for other subjects toward academic recognition (e.g., honor roll, class rank)?

- ☐ Yes, physical education is graded and it counts like other subjects (1)
- ☐ Yes, but it counts less than grades for other subjects (2)
- ☐ Yes, but it's on a pass/fail or satisfactory/unsatisfactory basis (3)
- ☐ No, but there are plans to change this (4)
- ☐ No, there are no grades (5)
- ☐ I do not know (6)

Q43 Does the school prohibit substitution of other courses or activities for physical education?

- ☐ Yes (1)
- ☐ Yes, but occasional exceptions are made (2)
- ☐ No, but there are plans to start prohibiting substitution (3)
- ☐ No (4)

Q44 Rate the status of school lunches and vending policies for healthy eating.

- ☐ Established programs and policies are in effect (1)
- ☐ Some efforts have been made but they are not well implemented (2)
- ☐ Little efforts have been made in this area but plans are evolving (3)
- ☐ No efforts have been undertaken and changes aren't likely (4)

Q45 Does the school/district offer a faculty/staff wellness program?

- ☐ Yes, and it is well received and well used (1)
- ☐ Yes, but it is not very comprehensive (2)
- ☐ No, but there have been discussions to start one (3)
- ☐ No, and there haven't been discussions about this (4)

Q46 You have just completed Section 4 of 4. Please click the next button at the bottom of this page to successfully send your responses.

## **APPENDIX C. NFL PLAY 60 FITNESSGRAM PROJECT ANNUAL SURVEY**

NFL PLAY 60 FITNESSGRAM Annual Survey--2014

Q1.1 Annual End of the Year Survey      NFL PLAY 60 FITNESSGRAM®

Q1.2 This survey provides valuable information reflecting participant involvement and satisfaction with FITNESSGRAM and various NFL PLAY 60 programs. Completion of this survey is required even if you have just joined the project. If you are involved in multiple locations, a survey must be completed for each site (i.e., school / organization). All survey data and results will be de-identified to protect the confidentiality of schools and individuals. This survey will take 10-20 minutes to complete and you may start and stop as your time permits. Answers will be saved automatically. Thank you for your time.

Q1.3 Please select the NFL team and site you are affiliated with:

(Table Truncated to 63 Columns)

Q1.4 At what type of site are you conducting the NFL PLAY 60 FITNESSGRAM project?

- ☐ On-site School Program -- your school will be conducting FITNESSGRAM in a school setting. (1)
- ☐ Off-site Program -- your organization will be conducting FITNESSGRAM during an after-school or off-site program such as a Boys and Girls Club or YMCA. (2)

Q1.5 Please select the NEXT (black button) located at the bottom of the page in order to advance to Section 1. This survey contains 7 sections.

Answer If SELECT APPROPRIATE SURVEY: At what type of site / sett... On-site School Program -- your school or organization will be conducting FITNESSGRAM assessment in a school setting. Is Selected

Q2.1 SECTION 1: FITNESSGRAM Information The following questions ask you to provide information about your use and experience with FITNESSGRAM based on this past school year only, unless otherwise indicated.

Q2.2 Various resources and training opportunities are available to ensure consistency within the project. Please select the type of resources and/or training you have or have not completed and when you completed it.

	Completed in previous year(s) but not in 2013-2014 (1)	Completed in 2013- 2014 (5)	No, have not yet completed / not offered (6)
Completed the Free Online FITNESSGRAM course through the FG website (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reviewed the FITNESSGRAM Test Administration Manual (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reviewed the FITNESSGRAM Training DVD (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Utilized the FITNESSGRAM Station Cards (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Visited the NFL PLAY 60 FITNESSGRAM Project Website (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<p>Reviewed and/or shared the FITNESSGRAM Aerobic Capacity and/or the Body Composition Vignettes (7)</p>	○	○	○
<p>Participated in a Webinar offered through the project (8)</p>	○	○	○
<p>Attended a school/district sponsored in-service FITNESSGRAM training session (9)</p>	○	○	○
<p>Corresponded directly with the NFL PLAY 60 FITNESSGRAM Project Team (10)</p>	○	○	○



Q2.3 How did the FITNESSGRAM resources and training opportunities help you the most?

- ☐ Provided me guidance in implementing the FITNESSGRAM software (1)
- ☐ Helped me improve my accuracy conducting the fitness tests (2)
- ☐ Increased my confidence implementing the fitness test with students (3)
- ☐ Enhanced my knowledge of health-related fitness components (4)
- ☐ Not Applicable (5)
- ☐ Other (6) \_\_\_\_\_

Q2.4 What did you find least helpful regarding the FITNESSGRAM resources and training opportunities?

- ☐ Not user friendly (1)
- ☐ Too technologically advanced (2)
- ☐ Too many resources, overwhelming (3)
- ☐ Felt the resources were all very helpful (4)
- ☐ Not applicable (5)
- ☐ Other (6) \_\_\_\_\_

Q2.5 How often did you use the NFL PLAY 60 FITNESSGRAM project website ([www.nflplay60fitnessgram.com](http://www.nflplay60fitnessgram.com))?

- ☐ Frequently (7)
- ☐ Occasionally (8)
- ☐ Not At All (9)

Q2.6 As a project participant, you have access to the FITNESSGRAM technology support through Human Kinetics. Did you (or have you) use this free service?

- ☐ Yes (1)
- ☐ No (2)
- ☐ Not Applicable (3)

Answer If As a project participant, you have access to the FITNESSG... Yes Is Selected

Q2.7 How satisfied were you with the FITNESSGRAM Technology Support Line (1-800-747-4457) customer service (not The Cooper Institute NFL PLAY 60 FITNESSGRAM project staff)?

- ☐ Very satisfied (1)
- ☐ Somewhat satisfied (2)
- ☐ Somewhat dissatisfied (3)
- ☐ Very dissatisfied (4)

Q2.8 Did you complete FITNESSGRAM testing in your school this past year?

- ☐ Yes (1)
- ☐ No (2)

Answer If Did you complete FITNESSGRAM testing on some (or all) of ... No Is Selected

Q2.9 What was the primary reason that prevented you from completing FITNESSGRAM testing?

- ☐ Low student interest or motivation (1)
- ☐ Lack of training on tests (2)
- ☐ Too much time involved (3)
- ☐ Did not meet curriculum or school priorities (4)
- ☐ Lack of administrative support (5)
- ☐ FITNESSGRAM 10 application is too difficult to use (6)
- ☐ Other (7) \_\_\_\_\_

Answer If Did you complete FITNESSGRAM testing on some (or all) of ... Yes Is Selected

Q2.10 Did students have the opportunity to practice the FITNESSGRAM tests prior to the collection of FITNESSGRAM scores for the project?

- ☐ Yes, we have provided our students with considerable opportunities for practice prior to testing (4 or more times) (1)
- ☐ Yes, we have provided our students with some limited opportunities for practice prior to testing (1-3 times) (2)
- ☐ No, however we have been able to provide our students with an opportunity to practice in previous years (3)
- ☐ No, we were not able to provide our students with opportunities for practice prior to testing (4)

Answer If Did you complete FITNESSGRAM testing on some (or all) of ... Yes Is Selected

Q2.11 How confident are you in the quality of FITNESSGRAM scores collected for the project?

- ☐ Very confident (1)
- ☐ Somewhat confident (2)
- ☐ Not confident (3)

Answer If How confident are you in the quality of FITNESSGRAM score... Not confident Is Selected

Q2.12 What is the primary reason you were not confident in the quality of the FITNESSGRAM scores?

- ☐ Limited knowledge, uncomfortable with the FITNESSGRAM protocol (1)
- ☐ Limited time to conduct FITNESSGRAM testing (2)
- ☐ Students tested one another, unsure if they reported accurately (3)
- ☐ Not enough support, too many students to test (4)
- ☐ Other (5) \_\_\_\_\_

Answer If Did you complete FITNESSGRAM testing in your school this ... Yes Is Selected

Q2.13 Did you utilize volunteers to help assist with FITNESSGRAM?

- ☐ Yes (1)
- ☐ No (2)

Answer If Did you complete FITNESSGRAM testing in your school this ... Yes Is Selected

Q2.14 Does using the test results collected through FITNESSGRAM make your teaching more effective?

- ☐ Definitely (1)
- ☐ Maybe (2)
- ☐ Probably not (3)
- ☐ Definitely not (4)

Answer If Did you complete FITNESSGRAM testing on some (or all) of ... Yes Is Selected

Q2.15 This past year, were student FITNESSGRAM scores entered into the FITNESSGRAM 10 software/application?

- ☐ Yes (1)
- ☐ No (2)

Answer If This past year, were&nbsp;student FITNESSGRAM scores&nbsp;... Yes Is Selected

Q2.16 What version of FITNESSGRAM are you currently using?

- ☐ Version 10 (the version supplied through this project fgontheweb.com/NFL) (1)
- ☐ Version 10 (supplied through my district) (2)
- ☐ Version 8 or 9 (3)
- ☐ Presidential Youth Fitness Program (PYFP) (4)
- ☐ Earlier version (5)
- ☐ A competitor's product (FITSTATS, WellNet) (6)
- ☐ Unsure (7) Different responses

Answer If This past year, were&nbsp;student FITNESSGRAM scores&nbsp;... Yes Is Selected

Q2.17 Rate your satisfaction with the FITNESSGRAM 10 web-based application.

- ☐ Very satisfied (1)
- ☐ Somewhat satisfied (2)
- ☐ Somewhat dissatisfied (3)
- ☐ Very dissatisfied (4)

Answer If Rate your satisfaction with the FITNESSGRAM 9 web-based a... Very dissatisfied Is Selected Or Rate your satisfaction with the FITNESSGRAM 9 web-based a... Somewhat dissatisfied Is Selected

Q2.18 What is the primary reason you were dissatisfied with the FITNESSGRAM 10 web-based application?

- ☐ Technologically difficult (1)
- ☐ Time consuming (2)
- ☐ Lack of support (3)
- ☐ Other (4) \_\_\_\_\_

Answer If This past year, were&nbsp;student FITNESSGRAM scores&nbsp;... No Is Selected

Q2.19 What was the primary reason your school did not enter the FITNESSGRAM scores into the FITNESSGRAM 10 software/application?

- ☐ Cost (1)
- ☐ Time (2)
- ☐ FG application too difficult - not user friendly (3)
- ☐ Limited access to technology (4)
- ☐ Lack of support (5)
- ☐ Other (6) \_\_\_\_\_

Answer If This past year, were&nbsp;student FITNESSGRAM scores&nbsp;... Yes Is Selected

Q2.20 A key advantage of FITNESSGRAM (and a key goal of the project) is to distribute FITNESSGRAM reports to parents and/or students at least once during the school year. Did your school distribute reports to parents and/or students?

- ☐ Yes, reports have been sent home to the parents and/or students (1)
- ☐ Reports have not been distributed, but we are planning on sending the reports home before the end of the school year (2)
- ☐ No, reports have not been sent home and we are not planning on sending reports home this year (3)

Answer If A key advantage of FITNESSGRAM (and a key goal of the pr... No, reports have not been sent home and we are not planning on sending reports home this year Is Selected

Q2.21 What was the primary reason your school did not send reports home to parents?

- ☐ Cost (1)
- ☐ Time (2)
- ☐ Policy (3)
- ☐ Other (4) \_\_\_\_\_

Answer If This past year, were&nbsp;student FITNESSGRAM scores&nbsp;... Yes Is Selected

Q2.22 What ways have you used your students' FITNESSGRAM data? Indicate how you have used your student's data by selecting yes or no next to each option.

	Yes (1)	No (2)
To help motivate students' to be physically active in the physical education classroom (1)	<input type="radio"/>	<input type="radio"/>
To help motivate students' to be physically active outside the school day (2)	<input type="radio"/>	<input type="radio"/>
To help teach health-related fitness concepts (3)	<input type="radio"/>	<input type="radio"/>
To determine program needs and direction (4)	<input type="radio"/>	<input type="radio"/>
To set instructional goals (5)	<input type="radio"/>	<input type="radio"/>
To advocate for physical education programs and services (6)	<input type="radio"/>	<input type="radio"/>
To promote awareness in parents (7)	<input type="radio"/>	<input type="radio"/>

To provide baseline data for long-term monitoring (8)	<input type="radio"/>	<input type="radio"/>
To satisfy school administration requirements (9)	<input type="radio"/>	<input type="radio"/>
Other (10)	<input type="radio"/>	<input type="radio"/>



Q2.23 These responses will not be shared with your administration and will only be used for the purposes of this project.

Answer If Did you complete FITNESSGRAM testing in your school this past year? Yes Is Selected

Q2.24 Do you include students with disabilities in your fitness testing?

- ☐ Yes (1)
- ☐ No (2)
- ☐ N/A (there are no students with disabilities in my classes) (3)

Answer If Do you include students with disabilities in your fitness testing? Yes Is Selected

Q2.25 What fitness test do you use?

- ☐ FITNESSGRAM (1)
- ☐ Brockport (2)
- ☐ Other (3) \_\_\_\_\_

Answer If Do you include students with disabilities in your fitness testing? Yes Is Selected

Q2.26 What type of disabilities do these students have?

- ☐ Autism (1)
- ☐ Deaf-blindness (2)
- ☐ Deafness (3)
- ☐ Emotional Disturbance (4)
- ☐ Hearing Impairment (5)
- ☐ Intellectual Disability (including Down Syndrome) (6)
- ☐ Multiple Disabilities (7)
- ☐ Orthopedic Impairment (Cerebral Palsy, Amputation) (8)
- ☐ Other Health Impairment (Asthma, Diabetes, Cancer) (9)
- ☐ Learning Disability (10)
- ☐ Speech or Language Impairment (11)
- ☐ Traumatic Brain Injury (12)
- ☐ Visual Impairment Including Blindness (13)
- ☐ Other (14) \_\_\_\_\_

Answer If Do you include students with disabilities in your fitness testing? No Is Selected

Q2.27 Why were these students not included?

- ☐ Lack of support/staff (1)
- ☐ Not enough time (2)
- ☐ Not enough space (3)
- ☐ Not enough modified equipment (4)
- ☐ Worried about safety (5)
- ☐ Did not know how to modify test/include students (6)
- ☐ Students could not follow FG protocol (7)
- ☐ Not required to test students with disabilities (8)
- ☐ Other (9) \_\_\_\_\_

Q2.28 You just completed Section 1 of 7. Please select the NEXT (black button) located at the bottom of the page in order to advance to Section 2.

Answer If SELECT APPROPRIATE SURVEY: At what type of site / sett... On-site School Program -- your school or organization will be conducting FITNESSGRAM assessment in a school setting. Is Selected

Q3.1 SECTION 2: Teacher Motivation The following questions ask you to provide information about your motivation to participate in the project.

Q3.2 Rate your level of engagement in the NFL PLAY 60 FITNESSGRAM project?

- ☐ Very engaged (1)
- ☐ Somewhat engaged (2)
- ☐ Minimally engaged (3)
- ☐ Not engaged (4)

Answer If Rate your level of engagement in the NFL PLAY 60 FITNESSGRAM partnership project? Very engaged Is Selected Or Rate your level of engagement in the NFL PLAY 60 FITNESSGRAM partnership project? Somewhat engaged Is Selected

Q3.3 Why did you participate in the project?

	Strongly Disagree (12)	Disagree (13)	Neither Agree nor Disagree (14)	Agree (15)	Strongly Agree (16)
So that I would be liked (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Because I would feel bad about myself if I didn't (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Because I believe it is important for my students (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Because I enjoy trying new things (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Because I want others to appreciate my work (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Because it gives me pleasure to try different things (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Because I care about students (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Because I felt I should (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Because I valued doing so (9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Because otherwise I would feel guilty (10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Answer If Rate your level of engagement in the NFL PLAY 60 FITNESSGRAM project?  
 Minimally engaged Is Selected Or Rate your level of engagement in the NFL PLAY 60  
 FITNESSGRAM project? Not engaged Is Selected

Q3.4 Why did you not engage in the NFL PLAY 60 FITNESSGRAM project?

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
Because I feel that I don't have the knowledge/skills/resources required to complete the project (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Because it requires a lot of effort to make it fit with my regular curriculum (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Because the value of the program is not clear to me (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Because the activities are not appropriate for my students (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Because the activities are too hard (or complicated) to follow (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q3.5 You just completed Section 2 of 7. Please select the NEXT (black button) located at the bottom of the page in order to advance to Section 3.

Answer If SELECT APPROPRIATE SURVEY: At what type of site / setting ... On-site School Program -- your school or organization will be conducting FITNESSGRAM assessment in a school setting. Is Selected

Q4.1 SECTION 3: NFL PLAY 60 Challenge Information The following questions provide information about your use and experiences with the NFL PLAY 60 Challenge program (a program founded by the American Heart Association and NFL).

Q4.2 Did you participate in the NFL PLAY 60 Challenge program this past school year?

- ☐ Yes (1)
- ☐ No (2)

Answer If In addition to using the NFL PLAY 60 FITNESSGRAM project ... Yes Is Selected

Q4.3 When did you implement the NFL PLAY 60 Challenge this past year?

- ☐ Fall (September-December) (1)
- ☐ Spring (January-May) (2)
- ☐ Fall AND Spring (3)
- ☐ Summer (4)
- ☐ Other (5) \_\_\_\_\_

Answer If Did you participate in the NFL PLAY 60 Challenge program ... Yes Is Selected

Q4.4 What prompted you to start using the NFL PLAY 60 Challenge program?

- ☐ The Cooper Institute project team (1)
- ☐ A representative from our NFL club (2)
- ☐ A NFL PLAY 60 Challenge representative (American Heart Association) (3)
- ☐ Our district/school administration personnel (4)
- ☐ Learned through professional communications/conferences (5)
- ☐ Other (6) \_\_\_\_\_

Answer If Did you participate in the NFL PLAY 60 Challenge program ... Yes Is Selected

Q4.5 Describe the type of resources you had to implement the program?

- ☐ We received a grant and extensive resources and support (1)
- ☐ We received extensive resources and support but no grant or funding (2)
- ☐ We had some resources provided to our school (3)
- ☐ We downloaded the resources from the internet and did the program on our own (4)
- ☐ Other (5) \_\_\_\_\_

Answer If In addition to using the NFL PLAY 60 FITNESSGRAM project ... Yes Is Selected

Q4.6 In carrying out the NFL PLAY 60 Challenge, how would you describe your level of implementation this past school year?

- ☐ Low Joining and building awareness for the Challenge. Sample activities include reviewing teacher manual, preparing for the 6 week challenge, introducing the students, staff, and administrators to the PLAY 60 Challenge. (1)
- ☐ Medium Promote and launch the NFL PLAY 60 Challenge encouraging students to be physically active 60 minutes each day. Sample activities include but are not limited to the following: creating a team to facilitate the Challenge, hosting a kick-off event, launching the PLAY 60 Challenge in the classrooms, and/or introducing students to the Student Game Planners and having them begin to log. (2)
- ☐ High Taking action in getting the entire school involved outside physical education. General classroom teachers participate by adding activity breaks to their classes, students continue to log in their game planners, you provide resources for students to take home or insert into school newsletters to encourage parents and caregivers to talk to students about their progress, and celebrate the successful achievement. Once the Challenge is over, you do not stop but you continue to lead your school in creating healthier school environments. (3)

Answer If Did you participate in the NFL PLAY 60 Challenge program this past school year?  
Yes Is Selected

Q4.7 Approximately what percent of students in your classes participated in the NFL PLAY 60 Challenge?

- ☐ Less than 30% (1)
- ☐ 30%-50% (2)
- ☐ 50%-70% (3)
- ☐ More than 70% (4)



Answer If Did you participate in the NFL PLAY 60 Challenge program this past school year?  
Yes Is Selected

Q4.8 How long did you implement the NFL PLAY 60 Challenge last year?

- ☐ Less than 1 month (1)
- ☐ 1-3 months (2)
- ☐ 4-6 months (4)
- ☐ More than 6 months (5)

Answer If Did you participate in the NFL PLAY 60 Challenge program ... Yes Is Selected

Q4.9 Overall, how satisfied were you with the NFL PLAY 60 Challenge?

- ☐ Very satisfied (1)
- ☐ Somewhat satisfied (2)
- ☐ Somewhat dissatisfied (3)
- ☐ Very dissatisfied (4)

Answer If Overall, how satisfied were you with the NFL PLAY 60 Chal... Somewhat dissatisfied  
Is Selected Or Overall, how satisfied were you with the NFL PLAY 60 Chal... Very dissatisfied  
Is Selected

Q4.10 What is the primary reason you were dissatisfied with NFL PLAY 60 Challenge?

- ☐ Too much time to implement (1)
- ☐ Cost (3)
- ☐ Program not easy to follow (4)
- ☐ Limited resources (5)
- ☐ Limited program support (6)
- ☐ Students did not enjoy (2)
- ☐ Other (7) \_\_\_\_\_

Answer If In addition to using the NFL PLAY 60 FITNESSGRAM project... Yes Is Selected

Q4.11 Would you implement the NFL PLAY 60 Challenge again in the future?

- ☐ Yes (1)
- ☐ No (3)
- ☐ Maybe (2)

Answer If In addition to using the NFL PLAY 60 FITNESSGRAM project ... No Is Selected

Q4.12 Please indicate the primary reason why you did not implement PLAY 60 Challenge:

- ☐ Cost (1)
- ☐ Time (2)
- ☐ Lack of support (3)
- ☐ Policy (4)
- ☐ Didn't know about the program/Wasn't aware of it (5)
- ☐ Other (6) \_\_\_\_\_

Q4.13 You just completed Section 3 of 7. Please select the NEXT (black button) located at the bottom of the page in order to advance to Section 4.

Answer If **SELECT APPROPRIATE SURVEY:**At what type of site / setting ... On-site School Program -- your school or organization will be conducting FITNESSGRAM assessment in a school setting. Is Selected

Q5.1 SECTION 4: NFL Fuel Up to Play 60 Information The following questions provide information about your use and experiences with the Fuel Up to Play 60 program (a program founded by the National Dairy Council and NFL, in collaboration with USDA).

Q5.2 Did you participate in the Fuel Up to Play 60 program this past school year (a grant is not required to participate)?

- ☐ Yes (1)
- ☐ No (2)

Q5.3 Were you aware that you can apply for grants to help support Fuel Up to Play 60 programming?

- ☐ Yes (1)
- ☐ No (2)

Answer If Were you aware that you can apply for grants to help supp... Yes Is Selected

Q5.4 Have you ever applied for and/or received a Fuel Up to Play 60 grant?

- ☐ Yes, our school applied and got funded (1)
- ☐ Yes, our school applied but did NOT receive funding (2)
- ☐ No, our school did not apply (3)
- ☐ Other (4) \_\_\_\_\_

Answer If Did you participate in the Fuel Up to Play 60 program spo... Yes Is Selected

Q5.5 When did you implement Fuel Up to Play 60 this past year?

- ☐ Fall (September-December) (1)
- ☐ Spring (January-May) (2)
- ☐ Fall AND Spring (3)
- ☐ Summer (4)
- ☐ Other (5) \_\_\_\_\_

Answer If Did you participate in the Fuel Up to Play 60 program thi... Yes Is Selected

Q5.6 What prompted you to start using the Fuel Up to Play 60 program?

- ☐ The Cooper Institute project team (1)
- ☐ A representative from our NFL Club (2)
- ☐ A Fuel Up to Play 60 representative (3)
- ☐ Our district/school administration personnel (4)
- ☐ Learned through professional communications/conferences (5)
- ☐ Other (6) \_\_\_\_\_

Answer If Did you participate in the Fuel Up to Play 60 program thi... Yes Is Selected

Q5.7 Describe the type of resources you had to implement the program?

- ☐ We received a grant and extensive resources and support (1)
- ☐ We received resources and support but no grant or funding (2)
- ☐ We had some resources provided to our school (3)
- ☐ We downloaded the resources from the internet and did the program on our own (4)
- ☐ Other (5) \_\_\_\_\_

Answer If Did you participate in the Fuel Up to Play 60 program thi... Yes Is Selected

Q5.8 In carrying out the Fuel Up to Play 60 project, how would you describe your level of implementation this past year?

- ☐ Low Joining and building awareness for participation in the FUTP 60 program. Example activities include but are not limited to the following: officially joining the program, reviewing the kit materials, and awareness activities such as passing out stickers, informing others, and having your students “pledge” on FUTP60.com (1)
- ☐ Medium Promote desired in-school actions/changes to nutrition and physical activity. Sample activities could be the following: holding a FUTP 60 kickoff event and completing at least one FUTP 60 activity such as visiting the FUTP 60 website, take the online pledge to eat healthy and get physically active, participate in a FUTP 60 Campaign (e.g., Make Your Move Campaign, It Starts With School Breakfast Campaign). (2)
- ☐ High Taking action to include activities that will improve the school nutrition and physical activity environment. Students are engaged and empowered, and working with adults at the school to implement healthy eating and physical activity “plays” to help improve the school environment. (3)

Answer If Did you participate in the Fuel Up to Play 60 program this past school year (a grant is not required... Yes Is Selected

Q5.9 Approximately what percent of students in your school participated in Fuel Up to Play 60?

- ☐ Less than 30% (1)
- ☐ 30%-50% (2)
- ☐ 50%-70% (3)
- ☐ More than 70% (4)

Answer If Did you participate in the Fuel Up to Play 60 program this past school year (a grant is not required... Yes Is Selected

Q5.10 How long did you implement Fuel Up to Play 60 last year?

- ☐ Less than 1 months (1)
- ☐ 1-3 months (2)
- ☐ 4-6 months (4)
- ☐ More than 6 months (5)

Answer If Did you participate in the Fuel Up to Play 60 program thi... Yes Is Selected

Q5.11 Overall, how satisfied were you with Fuel Up to Play 60?

- ☐ Very satisfied (1)
- ☐ Somewhat satisfied (2)
- ☐ Somewhat dissatisfied (3)
- ☐ Very dissatisfied (4)
- ☐ Undecided (5)

Answer If Overall, how satisfied were you with Fuel Up to Play 60? Somewhat dissatisfied Is Selected Or Overall, how satisfied were you with Fuel Up to Play 60? Very dissatisfied Is Selected

Q5.12 What is the primary reason you were dissatisfied with Fuel Up to Play 60?

- ☐ Too much time to implement (1)
- ☐ Cost (3)
- ☐ Program not easy to follow (4)
- ☐ Limited resources (5)
- ☐ Limited program support within our school or district (6)
- ☐ Students did not enjoy (2)
- ☐ Other (7) \_\_\_\_\_

Answer If Did you participate in the Fuel Up to Play 60 program spo... Yes Is Selected

Q5.13 Would you implement Fuel Up to Play 60 again in the future?

- ☐ Yes (1)
- ☐ No (3)
- ☐ Maybe (2)

Answer If Did you participate in the Fuel Up to Play 60 program spo... No Is Selected

Q5.14 Please indicate the primary reason why you did not implement Fuel Up to Play 60:

- ☐ Cost (1)
- ☐ Time (2)
- ☐ Lack of support (3)
- ☐ Policy (4)
- ☐ Didn't know about the program/Wasn't aware of it (5)
- ☐ Other (6) \_\_\_\_\_

Q5.15 You just completed Section 4 of 7. Please select the NEXT (black button) located at the bottom of the page in order to advance to Section 5.

Answer If SELECT APPROPRIATE SURVEY: At what type of site / sett... On-site School Program -- your school or organization will be conducting FITNESSGRAM assessment in a school setting. Is Selected

Q6.1 SECTION 5: NFL PLAY 60 Program InformationThe following questions provide information about your use and experiences with other NFL PLAY 60 Programs.

Q6.2 Has your school participated in any other NFL PLAY 60 programs this past school year?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I do not know (3)

Answer If Has your school participated in any additional NFL PLAY 60... Yes Is Selected

Q6.3 Which other NFL PLAY 60 programs did your school participate in? Indicate what additional programs you implemented by selecting yes or no next to each option.

	Yes (1)	No (2)
Back to Football/NFL PLAY 60 Super School (1)	<input type="radio"/>	<input type="radio"/>
The Bus Stops with You Contest (2)	<input type="radio"/>	<input type="radio"/>
NFL Flag Football (3)	<input type="radio"/>	<input type="radio"/>
NFL Punt, Pass, Kick (4)	<input type="radio"/>	<input type="radio"/>
ReCharge! or Mini ReCharge! (5)	<input type="radio"/>	<input type="radio"/>
NFL Girls Flag Football Leadership Program (7)	<input type="radio"/>	<input type="radio"/>
Hometown Huddle (8)	<input type="radio"/>	<input type="radio"/>
HOPSports (9)	<input type="radio"/>	<input type="radio"/>

Answer If Has your school participated in any additional NFL PLAY 6... Yes Is Selected

Q6.4 Did you participate in any other NFL PLAY 60 programs that have NOT been mentioned above?

- ☐ Yes (Please enter the name of the program) (1) \_\_\_\_\_
- ☐ No (2)
- ☐ I do not know (3)

Answer If Which additional NFL PLAY 60 programs did your school par... Back to Football/NFL PLAY 60 Super School - Yes Is Selected

Q6.5 How likely would you be to repeat the Back to Football/NFL PLAY 60 Super School program you already implemented?

- ☐ Very likely (1)
- ☐ Somewhat likely (2)
- ☐ Somewhat unlikely (4)
- ☐ Unlikely (5)

Answer If Which additional NFL PLAY 60 programs did your school par... The Bus Stops with You Contest - Yes Is Selected

Q6.6 How likely would you be to repeat The Bus Stops with You Contest you already implemented?

- ☐ Very likely (1)
- ☐ Somewhat likely (2)
- ☐ Somewhat unlikely (3)
- ☐ Unlikely (4)

Answer If Which additional NFL PLAY 60 programs did your school par... NFL Flag Football - Yes Is Selected

Q6.7 How likely would you be to repeat NFL Flag Football program you already implemented?

- ☐ Very likely (1)
- ☐ Somewhat likely (2)
- ☐ Somewhat unlikely (3)
- ☐ Unlikely (4)



Answer If Which additional NFL PLAY 60 programs did your school par... NFL Punt, Pass, Kick - Yes Is Selected

Q6.8 How likely would you be to repeat the NFL Punt, Pass, Kick program you already implemented?

- ☐ Very likely (1)
- ☐ Somewhat likely (2)
- ☐ Somewhat unlikely (3)
- ☐ Unlikely (4)

Answer If Which additional NFL PLAY 60 programs did your school par... ReCharge! or Mini ReCharge! - Yes Is Selected

Q6.9 How likely would you be to repeat the ReCharge! or Mini ReCharge! program you already implemented?

- ☐ Very likely (1)
- ☐ Somewhat likely (2)
- ☐ Somewhat unlikely (3)
- ☐ Unlikely (4)

Answer If Which additional NFL PLAY 60 programs did your school par... NFL Girls Flag Football Leadership Program - Yes Is Selected

Q6.11 How likely would you be to repeat the NFL Girls Flag Football Leadership Program you already implemented?

- ☐ Very likely (1)
- ☐ Somewhat likely (2)
- ☐ Somewhat unlikely (3)
- ☐ Unlikely (4)

Answer If Which additional NFL PLAY 60 programs did your school par... Hometown Huddle - Yes Is Selected

Q6.12 How likely would you be to repeat the Hometown Huddle program you already implemented?

- ☐ Very likely (1)
- ☐ Somewhat likely (2)
- ☐ Somewhat unlikely (3)
- ☐ Unlikely (4)

Answer If Which additional NFL PLAY 60 programs did your school par... HOPSports - Yes Is Selected

Q6.13 How likely would you be to repeat the HOPSports program you already implemented?

- ☐ Very likely (1)
- ☐ Somewhat likely (2)
- ☐ Somewhat unlikely (3)
- ☐ Unlikely (4)

Q6.14 You just completed Section 4 of 6. Please select the NEXT (black button) located at the bottom of the page in order to advance to Section 5.

Answer If SELECT APPROPRIATE SURVEY: At what type of site / sett... On-site School Program -- your school or organization will be conducting FITNESSGRAM assessment in a school setting. Is Selected

Q7.1 SECTION 6: Youth Activity Profile InformationThe following questions provide information about your use and experiences with the Youth Activity Profile (the computerized self-report measure of physical activity).

Q7.2 Did you administer the Youth Activity Profile to students this past year?

- ☐ Yes (1)
- ☐ No (2)

Answer If Did you administer the Youth Activity Profile (the comput... No Is Selected

Q7.3 What is the primary reason your school did not administer the Youth Activity Profile?

- ☐ Challenges in getting kids to access a computer (at school or at home) (1)
- ☐ It takes too much time out of the curriculum (2)
- ☐ Physical activity assessments are not a priority in our school (3)
- ☐ Other (4) \_\_\_\_\_

Answer If Did you administer the Youth Activity Profile (the comput... Yes Is Selected

Q7.4 Please select the month(s) that students completed the Youth Activity Profile (check all that apply).

- ☐ January (1)
- ☐ February (2)
- ☐ March (3)
- ☐ April (4)
- ☐ May (5)
- ☐ June (6)
- ☐ July (7)
- ☐ August (8)
- ☐ September (9)
- ☐ October (10)
- ☐ November (11)
- ☐ December (12)

Answer If Did you administer the Youth Activity Profile (the comput... Yes Is Selected

Q7.5 How did students complete the Youth Activity Profile?

- ☐ During physical education (1)
- ☐ In a non-physical education class (e.g., math, reading, or technology class) (2)
- ☐ As a homework assignment (3)
- ☐ Combination of in class (physical education or non-physical education course) and as homework (4)
- ☐ Other (5) \_\_\_\_\_

Answer If Did you administer the Youth Activity Profile (the comput... Yes Is Selected

Q7.6 Do your students value the feedback provided from the Youth Activity Profile?

- ☐ Yes (1)
- ☐ Somewhat (2)
- ☐ No (3)
- ☐ Unsure (4)

Q7.7 From the following, what do you feel is the most important way to use physical activity data (logs, questionnaires, activity profiles, etc)?

- ☐ Promoting student awareness about their own personal activity level (activity or inactivity) (1)
- ☐ Motivating students to be more physically active (2)
- ☐ Documenting levels of physical activity for curricular or programmatic purposes (3)
- ☐ Educating students about how physical activity relates to physical fitness (4)
- ☐ Sharing information with parents to promote parental involvement (5)

Q7.8 You just completed Section 6 of 7. Please select the NEXT (black button) located at the bottom of the page in order to advance to Section 7.

Answer If SELECT APPROPRIATE SURVEY: At what type of site / sett... On-site School Program -- your school or organization will be conducting FITNESSGRAM assessment in a school setting. Is Selected

Q8.1 SECTION 7: Program ReflectionPlease provide information about satisfaction with the project and impact at your school.

Q8.2 Has the focus on health-related fitness in your school had other impacts on school policies and/or programs related to physical activity?

- ☐ Definitely (6)
- ☐ Maybe (7)
- ☐ Probably not (11)
- ☐ Definitely not (12)

Answer If Has the focus on health-related fitness in your school ha... Definitely Is Selected Or  
Has the focus on health-related fitness in your school ha... Maybe Is Selected

Q8.3 How has this focus on health-related fitness impacted school policies and programs?

Indicate how health-related fitness has impacted your policies and programs by selecting yes or no next to each option.

	Yes (1)	No (2)
Additional opportunities for students to be physically active during the school day (e.g., classroom breaks) (1)	<input type="radio"/>	<input type="radio"/>
Access to school facilities before, after-school, and/or weekends (2)	<input type="radio"/>	<input type="radio"/>
Enhancements in recess programming (3)	<input type="radio"/>	<input type="radio"/>
After school activity programming (4)	<input type="radio"/>	<input type="radio"/>
Active involvement of parents in school physical education (5)	<input type="radio"/>	<input type="radio"/>
Increased budget or curriculum support for physical education (6)	<input type="radio"/>	<input type="radio"/>
More effective faculty wellness programming (7)	<input type="radio"/>	<input type="radio"/>

Not using physical activity as a form of punishment (8)	<input type="radio"/>	<input type="radio"/>
Additional NFL PLAY 60 activity promotion programs (e.g., Fuel Up to Play 60 and/or Play 60 Challenge) (9)	<input type="radio"/>	<input type="radio"/>
Other (please describe) (10)	<input type="radio"/>	<input type="radio"/>

Q8.4 This past year did your school participate in other activity promotion programs (e.g., running clubs, family fitness night)?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Q8.5 Please select the FITNESSGRAM and/or project related training you would be most interested in.

- ☐ Using FITNESSGRAM more effectively (e.g., testing, software) (1)
- ☐ Using FITNESSGRAM to build parent/community involvement (2)
- ☐ Promoting fitness education (3)
- ☐ Promoting physical activity (in physical education, outside of PE, and/or in the home) (4)
- ☐ Administering NFL PLAY 60 programming (e.g., PLAY 60 Challenge and/or Fuel Up to Play 60) (5)
- ☐ Data Mining such as how to use data to set instructional goals, long-term tracking, and using to advocate (6)

Q8.6 Did you attend the American Alliance for Health, Physical Education, Recreation, and Dance (AAHPERD) Conference this year? If so, did you have a chance to talk with the project team?

- ☐ Yes I attended, Yes I did talk with the project team (1)
- ☐ Yes I attended, No I did not talk with the project team (2)
- ☐ No I did not attend, Nor did I get a chance to talk with the project team (3)

Q8.7 In regards to the NFL PLAY 60 FITNESSGRAM project, please comment on your satisfaction with the communication and support you have received from The Cooper Institute Project Team.

- ☐ Very satisfied (1)
- ☐ Somewhat satisfied (2)
- ☐ Somewhat dissatisfied (3)
- ☐ Very dissatisfied (4)

Q8.8 Please provide any additional comments or suggestions in regards to the NFL PLAY 60 FITNESSGRAM project.

Q8.9 Please use the space below to report any success stories related to health and/or physical activity that have occurred at your school as a result of your schools' participation in the NFL PLAY 60 FITNESSGRAM project.

Q8.10 You have just completed Section 7 of 7. Please select the NEXT (black button) to submit your answers.